

Exhibit 1

AFFIDAVIT and DECLARATION OF AQUENE FREECHILD

AQUENE FREECHILD, being duly sworn, declares, under penalty of perjury pursuant to 28 U.S.C. § 1746, that the following is true and correct:

1. I am a resident of Mount Rainier, Maryland.
2. I voted in the 2016 general election in Mount Rainier, Maryland.
3. I am normally employed by Public Citizen, Inc., 215 Pennsylvania Ave. SE, Washington, DC 20003. I took a leave of absence Wednesday, November 23rd through Sunday, December 4th to work for Jill Stein's team on the Pennsylvania recount and continue to assist as a volunteer.
4. I am the volunteer coordinator in charge of the entire recount effort in Pennsylvania. I started working on the Pennsylvania recount as a volunteer passionate about making sure every vote was counted correctly.
5. Through our efforts, more than 1,300 individual Pennsylvania voters filed petitions for recounts in their voting precincts, representing at least 375 different voting precincts in 16 different counties throughout the State. Had the process of filing for a recount not been so inaccessible, this number would be much higher. All numbers in this affidavit are provided as information to the best of my knowledge, based on reports from individual volunteers and staff in the County boards of elections and the County courts.
6. To date, four counties—Allegheny, Chester, Lehigh, and Philadelphia—have conducted recounts of at least some precincts, started the process, or announced that the recount process will begin soon.
7. I have been following with great concern the problems with the reliability and security of our voting systems, and the ability to accurately verify the vote, since 2008. I have

long supported verifiable voting systems such as paper ballots (or lever) voting and public audits with random sampling adequate to detect any possible problems. The now widely available videos of esteemed professors easily hacking into the most commonly used touch screen and ballot scanning machines sounded the alarm.

8. My worries about the security of the vote increased this year when voter files in Illinois and Arizona, voting technology provider VR Systems, and the Democratic National Committee were all apparently attacked by hackers. As I understand it, most of these systems are far more resilient to hacking than our voting machines. Clearly there were skilled hackers taking an interest in this election.

9. I learned that Jill Stein was looking to conduct a recount in states with voting irregularities, and I reached out to connect with the campaign. I messaged some people on Facebook and through an online petition I started, and asked them to consider finding people in their precincts to file notarized petitions for a recount.

10. The response was like an overwhelming avalanche: Over 2,500 people wanted to participate in efforts to request a recount in Pennsylvania. Once the word got out, 50 and then 100 people were signing up per hour. Democrats, Republicans, Greens, and Libertarians volunteered to file affidavits. I was so encouraged by the outpouring of support for a recount. At least one Republican commented when they signed up to file an affidavit that they were happy with the election results but wanted to make help ensure that every vote had been counted.

11. Because this issue is so important, and because I feel so strongly about working across all parties to make sure every vote was counted properly and is verifiable in the future, I decided to take off work and volunteer full-time to help these fellow citizens file for a recount. I and dozens if not hundreds of other volunteers gave up our Thanksgiving time with family to try

to make sure everyone who volunteered had the resources they needed to file. My future in-laws in York county Pennsylvania supported my effort, allowing me to remain in Pennsylvania after Thanksgiving during this hectic organizing period.

Our Attempts to Organize Recount Petitions

12. The Election Code in Pennsylvania is so confusing that it took days for us to determine exactly what we needed to do to seek recounts. Without professional election lawyers paid for by the Jill Stein campaign, there is no way we could have moved forward. The election laws are impenetrable to ordinary citizens.

13. Indeed, we discovered almost immediately that the election laws appear just as confusing for election officials: Directors of different County Boards of Elections had totally different views of the law, one telling us it was too late to file after the five-day window including weekends, another saying we had plenty of time because it was five business days and many others who had no idea what to say or simply refused to answer our calls or emails. Our volunteers, who called their boards of elections as the very first step they took, were told conflicting information by various County Boards of Elections statewide.

14. It quickly became clear the County Boards were as confused as we were about how a recount was supposed to work. It is hard to blame them: The byzantine law on recounts is not clear or even internally consistent.

15. Our confusion was compounded by the fact that most County Boards of Elections did not post online when they had finished the first computation of the vote in the County.

16. For much of the weekend before the filing deadline, we were only pretty sure volunteers could file in about eight counties; the vast majority of counties we listed as “to be determined.” As volunteers without funds to hire expert legal advice in the initial organizing

period, and without clear information from the County Boards, we had to make our game plan based on the limited information available.

17. Some of the questions for which there was no answer and which volunteers debated endlessly included:

- a. Were we supposed to file petitions for a statewide recount only, or seek recounts through each county (or do both)?
- b. When we filed recount petitions with the counties, should we file in them court or with the County Board of Elections?
- c. By what date did the filing need to take place?
- d. Did all three petitioners from a given precinct or district need to take the day off of work and appear in person at the county seat to file, or could one filer submit petitions for multiple petitioners?
- e. How could voters find out which precinct they were in if multiple people from different precincts voted in the same location?
- f. When the state law refers to three voters per district, does “district” mean county, ward, division, or precinct?
- g. Will a recount be conducted only if three voters from every single precinct in a county file petitions?
- h. Where will recounts take place: in each precinct or somewhere else?
- i. Do petitioners have to pay a fee or not? If there is a fee, is the fee applied per petitioner or per precinct? And is the fee \$50 or \$100? Does that amount of the fee depend on the machines or the number of voters filing? Must the fee be paid in cash or do they take checks or credit cards?

- j. Is there a difference between the unofficial vote count posting date and the end of the canvass? Can a canvass go more than one day?
- k. Is there a difference between the computation of the vote and the certification of the vote?
- l. Given that we had five days after the canvass, can counties certify first thing in the morning of the fifth day and subsequently block citizen access on that fifth day?
- m. Was it worth organizing in one of the many precincts where no one was sure what the filing deadlines were?

18. There were no official answers to these questions available online, and we got conflicting answers every time we were able to reach a county staff person.

19. The cost of filing recount petitions, in time and money, represented an enormous barrier for voters who wished to seek recounts. Literally hundreds of people who wished to file a petition did not have the money or time to make copies, find a notary, arrange for transportation to the County Board, and pay potential filing fees, even if we could reimburse them afterward. When we asked voters if a \$50 petition fee would be a barrier to their filing, 420 out of over 2,000 volunteers indicated the fee was a barrier. Because we could not assure people that there would be no fee, some of those voters stayed home. If only one person was delivering petitions on behalf of three voters, that person had to have anywhere from \$150 to \$300 cash on hand, in case the fee was charged per person. If the volunteer planned to file petitions for more than one precinct, the volunteer would have to bring even more cash—something many volunteers were unable to do.

20. Other voters were not able to file petitions because they could not find two other voters from their voting district or precinct who were able to take time from work or childcare to get to a notary in the short window we had.

21. Even in counties where we had begun organizing early, we faced roadblocks and confusion. For example, our volunteers in Northampton had met frequently with election officials, and had gotten no clear answers or guidance on how to seek recounts. One volunteer in Delaware County went to the County Board of Elections meeting to request a recount, only to watch the Board certify the election results before she had a chance to speak. Jill Stein's ability to raise funds adequate to pay election lawyers to sort out the law over several days and draft an affidavit for voters to use was essential to making voter initiated recounts possible.

22. A woman called me from Philadelphia angry and distressed that she could not file petitions from her division, after learning about the recount on TV on Monday. Everyone she knew in her division was already at work, and she could not gather enough petitions to seek a recount. She subsequently called her state Representative, who in turn, called me to try to offer help. Our volunteers are smart, politically active people who know how to interact with their government, if only given enough information to do so.

23. There was no reasonable way for ordinary voters to navigate the legal process to file recount petitions without our help.

24. Given all of these unanswered questions, we could not assure voters, even on the day of filing, that if they took the time and effort to gather petitions and file them, potentially paying fees, their petitions would be accepted and recounts would be scheduled. This presented an enormous barrier that confused people and prevented hundreds, if not thousands of people, from filing petitions seeking recounts.

25. Attached as Exhibit A is a blank example of the petition and supporting exhibits we prepared for filing in counties using electronic voting machines, also called “DRE” machines. These petitions sought a forensic evaluation of the electronic voting machines.

26. Attached as Exhibit B is a blank example of the petition we prepared for filing in counties using paper ballots counted by optical scan machines. The petitions we filed attached the same supporting exhibits attached to those found in Exhibit A. These petitions sought a manual recount of all paper ballots.

Our Attempts to File Recount Petitions

27. For more than half the counties in the state, we literally had no way to find out by phone, email, or website search whether we could legally file for a recount on Monday, November 28. By Monday morning, there were at least 23 counties that had not certified their vote, according to Pennsylvania’s Department of State, but many of these same counties rejected our petitions. There was and is no consistent county- or state-level public record with information about when counties computed and certified their vote totals.

28. In Butler County, we were told the count was still going on Monday, November 28th morning when in fact the count had been certified.

29. In Cambria County on the 28th morning, we were told it was too late to file, when in fact the 5th day following the canvass was the 28th and it was in fact *not* too late.

30. In Schuylkill County, we called and emailed to try to find out if we could file our petitions. As of November 25, unofficial general election results were posted on the county’s website, but no date was visible to indicate when those results had been posted. We called the county’s Board of Elections first thing on the morning of November 28 and were told by the clerk that we could file our petitions. But when a volunteer named Larisa arrived at the

Schuylkill Board of Elections later that day, the clerk reportedly said to her, in sum and substance, “I know why you’re here. I am not going to take that [the notarized petition].” When the volunteer asked why, the staff member refused to tell the volunteer anything more. The volunteer asked if she could at least get some kind of receipt to show she had been there and had attempted to file her recount petitions, but the staff escorted her from the office. The volunteer called me immediately afterwards, shaken and frustrated, to relate her experience. This is not the way for public servants to treat respectful citizens exercising their rights.

31. In case after case, citizens were told to go to the courts by the County Boards of Elections, where they could be asked to pay court fees, even though they were apparently eligible to file for free with the County Boards. Some voters did not file in court because they could not afford the fees; others spent hundreds of dollars on fees if they were able to get the cash. Still others were also turned away from the courts as well, and missed the deadline because they were told they could not file by misinformed or hostile staff.

32. For example, I learned that in Berks County, the Board of Elections refused to accept petitions that volunteers attempted to file on November 28, 2016, referring the voters to the County Solicitor. The County Solicitor told the voters that they had to submit their petitions to the Prothonotary. When voters went to that office, the Prothonotary told them that they had to file with the Board of Elections. Finally, guidance from the Department of State indicated that petitions should be filed with the Prothonotary. However, the Prothonotary refused to accept petitions without a standard cover sheet, a proposed order, and filing fees totaling more than \$300. These instructions were not relayed until around 3:30 p.m., and the many of the voters were unable to assemble these materials and the requisite fees in time to file before the close of

the office at 4 p.m. Those voters' petitions were thus not filed, and all the time these voters had taken was wasted.

33. In Bucks County, I learned that a volunteer who had assembled petitions called the County Board of Elections to inquire whether they were accepting petitions. The County Board told the voter that he would need a lawyer, must file with the Prothonotary, and had to pay a fee of over \$230. When the voter called the Prothonotary, the office had no guidance and told the voter that the office needed to confer with the County Solicitor.

34. Despite these many barriers, persistent voters were able to file recount requests for 375 precincts across the state, to the best of our knowledge. People in 28 counties organized to file, though not all were ultimately able to. Sadly only four counties thus far have granted recounts.

35. The enormous gap between the number of counties where voters intended to file (28) and where they were able to file (16) reflects the profound difficulty far too many voters faced. Lack of communication by county boards of elections with voters—a problem that continues now, even as recounts are pending—is a huge problem. Hundreds of people signed up to file affidavits who reside in counties where, after much searching and calling, we were able to determine that the canvass date had been more than five days passed, making recount petitions untimely.

36. These stringent requirements ultimately favor voters in bigger cities who have access to more available notaries, transit options, and a greater numbers of volunteer lawyers who can assist voters with filing their petitions.

Misinformation and Confusion from State and County Officials

37. The lack of information available to citizens about how to access the recount process places an enormous burden on the voters' right to request a recount.

38. In many counties, just like Bucks County, I learned that voters were told by the county Boards of Elections to contact the Prothonotary, and were told by the Prothonotary to contact the Boards. I was told by volunteers in Northampton County, that the Board of Elections accepted some petitions on November 28, but then later that same day turned other petitioners away, telling them that they would have to file their petitions in court and pay filing fees. In York County, voters had filed petitions with the Prothonotary in the morning, but a voter who arrived later in the day was sent by the Prothonotary to the Board of Elections to file her petition. Because she was the third filer for her precinct, and the Prothonotary had accepted the first two affidavits from her same precinct early in the day, they were not able to file a full precinct as required by the law to request a recount. It was not until this morning, December 5, 2016—a full week after we attempted to file recount petitions, and after *daily* calls and emails—that York County Board officials told me that the County had certified its vote at noon on November 28.

39. Often County Boards refused to give our volunteers *any* information about how and where to seek recounts. I learned that in Butler County, for example, the Board of Elections refused to accept petitions and told voters nothing more than that they should consult with an attorney. Similar answers were given to some voters in Delaware County. In Montgomery County, a voter was told that the Board of Elections would accept petitions, but when asked for additional information, the clerk from the Board of Elections told the voter only that the voter should contact an attorney.

40. In fact, the Delaware County Board of Elections gave some voters, when they submitted their petitions to the Board, a letter saying, "Election law as passed by the legislature

and interpreted by the Courts has become increasingly complex,” but notes that the “burden of accuracy of all filings . . . is upon the individual the documents are submitted on behalf of.”

Attached as Exhibit C is to the best of my knowledge a true and correct copy of the letter that the County Board provided to some petitioners.

41. Further, the Delaware County Board time-stamped petitions for at least one complete precinct, but now refuses to confirm in phone calls that these petitions were received or whether a recount or any further proceedings will take place.

42. Even now more than, ten days after our efforts began, and after constant phone calls and visits to the County Boards of Election, I *still* do not know what the deadlines for filing recount petitions were in some counties, or even whether our filings were accepted.

43. A few County Boards of Elections still refuse to communicate clearly about the recount process with residents of the county—or to even acknowledge and respond about whether or not their recount petitions were accepted, and what the next steps might be.

Conclusion

44. Even with the rampant confusion wrought by unclear laws, lack of public information, and conflicting instructions from State and County officials, thousands of people across Pennsylvania took the time to read and sign petitions, get them notarized, gather petitions from their neighbors, and attempt to file them with County boards or the courts. In addition to the 1,125 people who took the time to file affidavits in groups of three for precinct recounts, 226 individual people filed individual affidavits. If the process had been accessible and clear, many more people would have exercised their rights and had time to find neighbors to take part in the filing.

45. In addition to the more than 1,300 people who volunteered to help this effort, at least another 500 people signed up on the Pennsylvania volunteer recount survey and on ally sites to file affidavits for a recount who did not end up filing. Many of these voters could not find a third person in their precinct and so they missed their opportunity to seek a recount. Even more people signed up directly through the Green Party and Stein campaign directly.

46. The effort I have expended to organize thousands of voters to file petitions for a recount has reaffirmed my belief that voters are hungry for assurance that their votes are counted accurately and fairly. I am equally convinced that Pennsylvania's laws make it nearly impossible for voters to be so assured. From the electronic voting machines with no paper receipt, to the utterly opaque procedures for seeking the recounts provided by law, to the repeated denials of any forensic inspection that could actually find a problem with the count in the first place, Pennsylvania places enormous barriers in the way of ordinary voters who want their voices heard and their votes counted.

47. I am concerned that the votes of my fellow citizens were not counted accurately in the election, and would like a manual recount of every paper ballot and a forensic examination of the electronic voting systems in Pennsylvania to make the vote had integrity and every vote counted.

Dated: December 5th, 2016


AQUENE FREECHILD

Sworn to and subscribed before me

this 5 day of December, 2016.



NOTARY PUBLIC

**My Commission Expires
February 28, 2021**





For more information, please contact the District of Columbia Department of Public Works at (202) 724-2000.

Exhibit A

COMMONWEALTH OF PENNSYLVANIA
COUNTY OF _____

PETITION TO RECOUNT AND/OR RECANVASS
AND AFFIDAVIT OF [your name] _____

**TO THE _____ COUNTY BOARD OF ELECTIONS, [name of
county]_____, PENNSYLVANIA:**

_____, verifies, deposes and says the following under penalty of
perjury:

1. My name is _____. I am a registered voter in City, Borough,
Township of _____, Precinct [insert number] _____,
_____ County, Pennsylvania. I voted in this district in the election on
November 8, 2016. I live at [insert complete street address]
_____, _____ County, Pennsylvania.

2. Pursuant to 25 P.S. § 3154, I request a recount and recanvass of the vote for
President of the United States and for United States Senate in the November 8, 2016 election in
this district.

3. I believe that an error, although not apparent on the face of the returns, has been
committed in the vote in this district. I also believe there is a discrepancy in the returns of this
district.

4. My belief is based, in part, on the attached Affidavit of Alex Halderman, which
raises grave concerns about the integrity of DRE voting machines used in this district. *See* Ex. A
(attached).

5. I request that the county board not just recanvass the votes cast on the DRE machines, but do a forensic analysis of the software and media inside the machines, to determine whether the machines have been hacked or tampered with. As the Halderman affidavit makes clear, merely recanvassing the votes on the machines will not detect whether the machines have been compromised.

6. At minimum, I request that a reasonable subset of the DRE machines be forensically analyzed by appropriate computer experts for potential tampering, malware, and/or hacking.

7. As a voter, and as a citizen of this country, I believe it is extremely important that votes are counted accurately in this election.

8. I hereby verify under penalty of perjury that the facts contained in this petition and affidavit are true and correct to the best of my knowledge or information and belief.

[signature]

Sworn to before me this _____ day of November 2016.

Notary Public

VERIFICATION

I hereby depose and say that the statements in the foregoing Petition to Recount and/or Recanvass are true and correct to the best of my knowledge, information and belief. I understand that this statement is made subject to the penalties of 18 Pa. C. S. Sec 4904 relating to unsworn falsification to authorities.

[signature]

AFFIDAVIT OF J. ALEX HALDERMAN

J. ALEX HALDERMAN, being duly sworn, deposes and says the following under penalty of perjury:

1. My name is J. Alex Halderman. I am a Professor of Computer Science and Engineering and the Director of the Center for Computer Security and Society at the University of Michigan in Ann Arbor, Michigan.
2. I have a Ph.D., a Master's Degree, and a Bachelor's Degree in Computer Science, all from Princeton University.
3. My research focuses on computer security and privacy, with an emphasis on problems that broadly impact society and public policy. Among my areas of research are software security, data privacy, and electronic voting.
4. I have published peer-reviewed research analyzing the security of electronic voting systems used in Pennsylvania, other U.S. states, and other countries. I was part of a team of experts commissioned by the California Secretary of State to conduct a "Top-to-Bottom" review of the state's electronic voting systems. I have also investigated methods for improving the security of electronic voting, such as efficient techniques for testing whether electronic vote totals match paper vote records.
5. I have published numerous other peer-reviewed papers in these areas of research. My full curriculum vitae, including a list of honors and awards, research projects, and publications, is attached as Exhibit A.

Context: Cyberattacks and the 2016 Presidential Election

6. The 2016 presidential election was subject to unprecedented cyberattacks apparently intended to interfere with the election. This summer, attackers broke into the email

system of the Democratic National Committee and, separately, into the email account of John Podesta, the chairman of Secretary Clinton's campaign. Exhibits B and C. The attackers leaked private messages from both hacks. Attackers also infiltrated the voter registration systems of two states, Illinois and Arizona, and stole voter data. Exhibit D. The Department of Homeland Security has stated that senior officials in the Russian government commissioned these attacks. Exhibit E. Attackers attempted to breach election offices in more than 20 other states. Exhibit F.

7. Russia has sophisticated cyber-offensive capabilities, and it has shown a willingness to use them to hack elections elsewhere. For instance, according to published reports, during the 2014 presidential election in Ukraine, attackers linked to Russia sabotaged Ukraine's vote-counting infrastructure, and Ukrainian officials succeeded only at the last minute in defusing vote-stealing malware that could have caused the wrong winner to be announced. Exhibit G. Countries other than Russia also have similarly sophisticated cyberwarfare capabilities.

8. If a foreign government were to attempt to hack American voting machines to influence the outcome of a presidential election, one might expect the attackers to proceed as follows. First, the attackers might probe election offices well in advance to find ways to break into the computers. Next, closer to the election, when it was clear from polling data which states would have close electoral margins, the attackers might spread malware into voting machines into some of these states, manipulating the machines to shift a few percent of the vote to favor their desired candidate. This malware would likely be designed to remain inactive during pre-election tests, perform its function during the election, and then erase itself after the polls closed. One would expect a skilled attacker's work to leave no visible signs, other than a

surprising electoral outcome in which results in several close states differed from pre-election polling.

The Vulnerability of American Voting Machines to Cyberattack

9. As I and other experts have repeatedly documented in peer-reviewed and state-sponsored research, American voting machines have serious cybersecurity problems. Voting machines are computers with reprogrammable software. An attacker who can modify that software by infecting the machines with malware can cause the machines to provide any result of the attacker's choosing. As I have demonstrated in laboratory tests, in just a few seconds, anyone can install vote-stealing malware on a voting machine that silently alters the electronic records of every vote.¹

10. Whether voting machines are connected to the Internet is irrelevant. Shortly before each election, poll workers copy the ballot design from a regular desktop computer in a government office and use removable media (akin to the memory card in a digital camera) to load the ballot design onto each machine. That initial computer is almost certainly not well enough secured to guard against attacks by foreign governments. If technically sophisticated attackers infect that computer, they can spread vote-stealing malware to every voting machine in the area. Technically sophisticated attackers can accomplish this with ease.

11. While the vulnerabilities of American voting machines have been known for some time, states' responses to these vulnerabilities have been patchy and inconsistent at best. Many states, including Pennsylvania, continue to use out-of-date machines that are known to be insecure.

¹ A video documenting this result is publicly available at <https://youtu.be/aZws98jw67g>.

Where Paper is Available, Examining the Paper Record Is the Only Way to Ensure the Integrity of the Result; For Paperless DRE Machines, Forensic Examination is the Only Way to Ensure the Integrity of the Result

12. Paper ballots are the best and most secure technology available for casting votes. Optical scan voting allows the voter to fill out a paper ballot that is scanned and counted by a computer. Electronic voting machines with voter-verified paper audit trails allow the voter to review a printed record of the vote he has just cast on a computer. Only a paper record documents the vote in a manner that cannot later be modified by malware or other forms of cyberattacks.

13. One explanation for the results of the 2016 presidential election is that cyberattacks influenced the result. This explanation is plausible, in light of other known cyberattacks intended to affect the outcome of the election; the profound vulnerability of American voting machines to cyberattack; and the fact that a skilled attacker would leave no outwardly visible evidence of an attack other than an unexpected result.

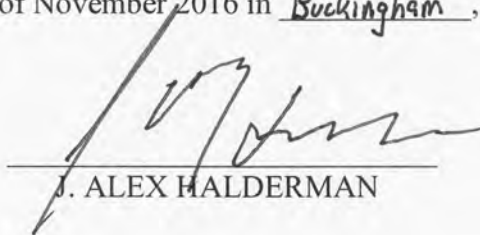
14. The only way to determine whether a cyberattack affected the outcome of the 2016 presidential election is to examine the available physical evidence—that is, to count the paper ballots and paper audit trail records, and review the voting equipment, to ensure that the votes cast by actual voters match the results determined by the computers.

15. For ballots cast through optical scanners, a manual recount of the paper ballots, without relying on the electronic equipment, must occur. Using the electronic equipment to conduct the recount, even after first evaluating the machine through a test deck, is insufficient. Attackers intending to commit a successful cyberattack could, and likely would, create a method to undermine any pre-tests. For votes cast on electronic voting machines, such as DREs, the paper audit trail records (if any) must be counted, since the electronic records stored in the machines

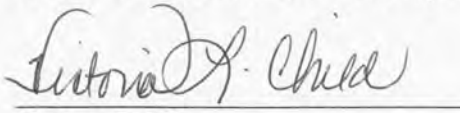
could have been manipulated in an attack. But this is insufficient to uncover many types of hacking and malware. Voting equipment that might yield forensic evidence of an attack includes the voting machines, removable media, and election management system computers. All of these must be forensically analyzed to ensure the integrity of the result. Paperless DRE voting machines do not create any physical record of each vote, so forensic examination of the equipment is the only way to assure that the machines were not manipulated in a cyberattack. Paper ballots, paper audit trails, and voting equipment will only be examined in this manner if there is a recount.

16. A recount is the best way, and indeed the only way, to ensure public confidence that the results are accurate, authentic, and untainted by interference. It will also set a precedent that may provide an important deterrent against cyberattacks on future elections.

This affidavit was executed on the 25th day of November 2016 in Buckingham, Pennsylvania.


J. ALEX HALDERMAN

Sworn to before me this 25th day of November 2016.


Notary Public

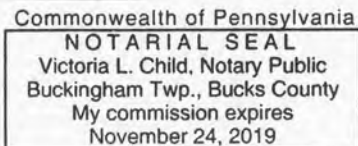


Exhibit A

J. Alex Halderman

Professor, Computer Science and Engineering
University of Michigan

November 4, 2016

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jhalderm@eecs.umich.edu

J.AlexHalderman.com

Research Overview

My research focuses on computer security and privacy, with an emphasis on problems that broadly impact society and public policy. Topics that interest me include software security, network security, data privacy, anonymity, surveillance, electronic voting, censorship resistance, digital rights management, computer forensics, ethics, and cybercrime. I'm also interested in the interaction of technology with law, regulatory policy, and international affairs.

Selected Projects

'16: Let's Encrypt HTTPS certificate authority	'10: Vulnerabilities in India's e-voting machines
'15: Weak Diffie-Hellman and the Logjam attack	'10: Reshaping developers' security incentives
'14: Understanding Heartbleed's aftermath	'09: Analysis of China's Green Dam censorware
'14: Security problems in full-body scanners	'09: Fingerprinting paper with desktop scanners
'14: Analysis of Estonia's Internet voting system	'08: Cold-boot attacks on encryption keys
'13: ZMap Internet-wide network scanner	'07: California's "top-to-bottom" e-voting review
'12: Widespread weak keys in network devices	'07: Machine-assisted election auditing
'11: Anticensorship in the network infrastructure	'06: The Sony rootkit: DRM's harmful side effects
'10: Hacking Washington D.C.'s Internet voting	'03: Analysis of MediaMax "shift key" DRM

Positions

- University of Michigan, Ann Arbor, MI
Department of Electrical Engineering and Computer Science,
Computer Science and Engineering Division
Professor ... (2016–present)
Associate Professor ... (2015–2016)
Assistant Professor ... (2009–2015)
Director, Center for Computer Security and Society (2014–present)

Education

- Ph.D. in Computer Science, Princeton University, June 2009
Advisor: Ed Felten
Thesis: *Investigating Security Failures and their Causes: An Analytic Approach to Computer Security*
Doctoral committee: Andrew Appel, Adam Finkelstein, Brian Kernighan, Avi Rubin
- M.A. in Computer Science, Princeton University, June 2005
- A.B. in Computer Science, *summa cum laude*, Princeton University, June 2003

Honors and Awards

- Pwnie Award in the category of “Best Cryptographic Attack” for “DROWN: Breaking TLS using SSLv2,” Black Hat 2016
- Finalist for 2016 Facebook Internet Defense Prize for “DROWN: Breaking TLS using SSLv2”
- Named one of Popular Science’s “[Brilliant 10](#)” (2015) (“each year *Popular Science* honors the brightest young minds reshaping science, engineering, and the world”)
- **Best Paper Award** of the 22nd ACM Conference on Computer and Communications Security for “Imperfect Forward Secrecy: How Diffie-Hellman Fails in Practice” (2015)
- Pwnie Award in the category of “Most Innovative Research” for “Imperfect Forward Secrecy: How Diffie-Hellman Fails in Practice,” Black Hat 2015
- IRTF [Applied Networking Research Prize](#) for “Neither Snow Nor Rain Nor MITM... An Empirical Analysis of Email Delivery Security” (2015)
- Alfred P. Sloan Research Fellowship (2015)
- University of Michigan College of Engineering 1938 E Award (2015) (“recognizes an outstanding teacher in both elementary and advanced courses, an understanding counselor of students who seek guidance in their choice of a career, a contributor to the educational growth of his/her College, and a teacher whose scholarly integrity pervades his/her service and the profession of Engineering”)
- Morris Wellman Faculty Development Assistant Professorship (2015) (“awarded to a junior faculty member to recognize outstanding contributions to teaching and research”)
- **Best Paper Award** of the 14th ACM Internet Measurement Conference for “The Matter of Heartbleed” (2014)
- **Best Paper Award** of the 21st USENIX Security Symposium for “Mining Your Ps and Qs: Detection of Widespread Weak Keys in Network Devices” (2012)
- Runner-up for 2012 PET Award for Outstanding Research in Privacy Enhancing Technologies for “Telex: Anticensorship in the Network Infrastructure” (2012)
- John Gideon Memorial Award from the Election Verification Network for contributions to election verification (2011)
- **Best Student Paper** of the 17th USENIX Security Symposium for “Lest We Remember: Cold Boot Attacks on Encryption Keys” (2008)
- Pwnie Award in the category of “Most Innovative Research” for “Lest We Remember: Cold Boot Attacks on Encryption Keys,” Black Hat 2008
- Charlotte Elizabeth Procter Honorific Fellowship, Princeton University (2007) (“awarded in recognition of outstanding performance and professional promise, and represents high commendation from the Graduate School”)
- National Science Foundation Graduate Research Fellowship (2004–2007)

- Best Paper Award of the 8th International Conference on 3D Web Technology for “Early Experiences with a 3D Model Search Engine” (2003)
- Princeton Computer Science Department Senior Award (2003)
- Accenture Prize in Computer Science, Princeton University (2002)
- Martin A. Dale Summer Award, Princeton University (2000)
- USA Computing Olympiad National Finalist (1996 and 1997)

Refereed Conference Publications

[1] The Security Impact of HTTPS Interception

Zakir Durumeric, Zane Ma, Drew Springall, Richard Barnes, Nick Sullivan, Elie Bursztein, Michael Bailey, J. A. Halderman, and Vern Paxson

To appear in *Proc. 24th Network and Distributed Systems Symposium (NDSS)*, February 2017.
Acceptance rate: 16%, 68/423.

[2] Measuring Small Subgroup Attacks Against Diffie-Hellman

Luke Valenta, David Adrian, Antonio Sanso, Shaanan Cohney, Joshua Fried, Marcella Hastings, J. A. Halderman, and Nadia Heninger

To appear in *Proc. 24th Network and Distributed Systems Symposium (NDSS)*, February 2017.
Acceptance rate: 16%, 68/423.

[3] An Internet-Wide View of ICS Devices

Ariana Mirian, Zane Ma, David Adrian, Matthew Tischer, Thasphon Chuenchujit, Tim Yardley, Robin Berthier, Josh Mason, Zakir Durumeric, J. A. Halderman and Michael Bailey

To appear in *Proc. 14th IEEE Conference on Privacy, Security, and Trust (PST)*, December 2016.

[4] Implementing Attestable Kiosks

Matthew Bernhard, J. A. Halderman, and Gabe Stocco

To appear in *Proc. 14th IEEE Conference on Privacy, Security, and Trust (PST)*, December 2016.

[5] Measuring the Security Harm of TLS Crypto Shortcuts

Drew Springall, Zakir Durumeric, and J. A. Halderman

To appear in *Proc. 16th ACM Internet Measurement Conference (IMC)*, Santa Monica, Nov. 2016.
Acceptance rate: 25%, 46/184.

[6] Towards a Complete View of the Certificate Ecosystem

Benjamin VanderSloot, Johanna Amann, Matthew Bernhard, Zakir Durumeric, Michael Bailey, and J. A. Halderman

To appear in *Proc. 16th ACM Internet Measurement Conference (IMC)*, Santa Monica, Nov. 2016.
Acceptance rate: 25%, 46/184.

[7] **DROWN: Breaking TLS using SSLv2**

Nimrod Aviram, Sebastian Schinzel, Juraj Somorovsky, Nadia Heninger, Maik Dankel, Jens Steube, Luke Valenta, David Adrian, J. A. Halderman, Viktor Dukhovni, Emilia Käsper, Shaanan Cohney, Susanne Engels, Christof Paar, and Yuval Shavitt

Proc. 25th USENIX Security Symposium, Austin, TX, August 2016.

Acceptance rate: 16%, 72/463.

Tied for highest ranked submission.

Pwnie award for best cryptographic attack.

Facebook Internet Defense Prize finalist.

[8] **FTP: The Forgotten Cloud**

Drew Springall, Zakir Durumeric, and J. A. Halderman

Proc. 46th IEEE/IFIP International Conference on Dependable Systems and Networks (DSN), Toulouse, June 2016.

Acceptance rate: 22%, 58/259.

[9] **Android UI Deception Revisited: Attacks and Defenses**

Earlence Fernandes, Qi Alfred Chen, Justin Paupore, Georg Essl, J. A. Halderman, Z. Morley Mao, and Atul Prakash

Proc. 20th International Conference on Financial Cryptography and Data Security (FC), Barbados, February 2016.

[10] **Imperfect Forward Secrecy: How Diffie-Hellman Fails in Practice**

David Adrian, Karthikeyan Bhargavan, Zakir Durumeric, Pierrick Gaudry, Matthew Green, J. A. Halderman, Nadia Heninger, Drew Springall, Emmanuel Thomé, Luke Valenta, Benjamin VanderSloot, Eric Wustrow, Santiago Zanella-Béguélin, and Paul Zimmermann

Proc. 22nd ACM Conference on Computer and Communications Security (CCS), Denver, CO, October 2015.

Acceptance rate: 19%, 128/659.

Best paper award. Perfect review score.

Pwnie award for most innovative research.

[11] **Censys: A Search Engine Backed by Internet-Wide Scanning**

Zakir Durumeric, David Adrian, Ariana Mirian, Michael Bailey, and J. A. Halderman

Proc. 22nd ACM Conference on Computer and Communications Security (CCS), Denver, CO, October 2015.

Acceptance rate: 19%, 128/659.

[12] **Neither Snow Nor Rain Nor MITM... An Empirical Analysis of Email Delivery Security**

Zakir Durumeric, David Adrian, Ariana Mirian, James Kasten, Elie Bursztein, Nicholas Lidzborski, Kurt Thomas, Vijay Eranti, Michael Bailey, and J. A. Halderman

Proc. 15th ACM Internet Measurement Conference (IMC), Tokyo, October 2015.

Acceptance rate: 26%, 44/169.

IRTF Applied Networking Research Prize winner.

- [13] **The New South Wales iVote System:
Security Failures and Verification Flaws in a Live Online Election**
J. A. Halderman and Vanessa Teague
Proc. 5th International Conference on E-Voting and Identity (VoteID), Bern, Switzerland, September 2015.
- [14] **The Matter of Heartbleed**
Zakir Durumeric, Frank Li, James Kasten, Johanna Amann, Jethro Beekman, Mathias Payer, Nicolas Weaver, David Adrian, Vern Paxson, Michael Bailey, and J. A. Halderman
Proc. 14th ACM Internet Measurement Conference (IMC), November 2014.
Acceptance rate: 23%, 43/188
Best paper award.
Honorable mention for Best dataset award.
- [15] **Security Analysis of the Estonian Internet Voting System**
Drew Springall, Travis Finkenauer, Zakir Durumeric, Jason Kitcat, Harri Hursti, Margaret MacAlpine, and J. A. Halderman
Proc. 21st ACM Conference on Computer and Communications Security (CCS), Scottsdale, AZ, November 2014.
Acceptance rate: 19%, 114/585.
Highest ranked submission.
- [16] **Efficiently Auditing Multi-Level Elections**
Joshua A. Kroll, Edward W. Felten, and J. A. Halderman
Proc. 6th International Conference on Electronic Voting (EVOTE), Lochau, Austria, October 2014.
- [17] **Security Analysis of a Full-Body Scanner**
Keaton Mowery, Eric Wustrow, Tom Wypych, Corey Singleton, Chris Comfort, Eric Rescorla, Stephen Checkoway, J. A. Halderman, and Hovav Shacham
Proc. 23rd USENIX Security Symposium, San Diego, CA, August 2014.
Acceptance rate: 19%, 67/350.
- [18] **TapDance: End-to-Middle Anticensorship without Flow Blocking**
Eric Wustrow, Colleen Swanson, and J. A. Halderman
Proc. 23rd USENIX Security Symposium, San Diego, CA, August 2014.
Acceptance rate: 19%, 67/350.
- [19] **An Internet-Wide View of Internet-Wide Scanning**
Zakir Durumeric, Michael Bailey, and J. A. Halderman
Proc. 23rd USENIX Security Symposium, San Diego, CA, August 2014.
Acceptance rate: 19%, 67/350.
- [20] **Elliptic Curve Cryptography in Practice**
Joppe W. Bos, J. A. Halderman, Nadia Heninger, Jonathan Moore, Michael Naehrig, and Eric Wustrow
Proc. 18th Intl. Conference on Financial Cryptography and Data Security (FC), March 2014.
Acceptance rate: 22%, 31/138.

- [21] **Outsmarting Proctors with Smartwatches: A Case Study on Wearable Computing Security**
 Alex Migicovsky, Zakir Durumeric, Jeff Ringenberg, and J. A. Halderman
Proc. 18th Intl. Conference on Financial Cryptography and Data Security (FC), March 2014.
 Acceptance rate: 22%, 31/138.
- [22] **Analysis of the HTTPS Certificate Ecosystem**
 Zakir Durumeric, James Kasten, Michael Bailey, and J. A. Halderman
Proc. 13th ACM Internet Measurement Conference (IMC), Barcelona, Spain, October 2013.
 Acceptance rate: 24%, 42/178.
- [23] **ZMap: Fast Internet-Wide Scanning and its Security Applications**
 Zakir Durumeric, Eric Wustrow, and J. A. Halderman
Proc. 22nd USENIX Security Symposium, Washington, D.C., August 2013.
 Acceptance rate: 16%, 45/277.
- [24] **CAGE: Taming Certificate Authorities by Inferring Restricted Scopes**
 James Kasten, Eric Wustrow, and J. A. Halderman
Proc. 17th Intl. Conference on Financial Cryptography and Data Security (FC), April 2013.
- [25] **Mining Your Ps and Qs: Detection of Widespread Weak Keys in Network Devices**
 Nadia Heninger, Zakir Durumeric, Eric Wustrow, and J. A. Halderman
Proc. 21st USENIX Security Symposium, pages 205–220, Bellevue, WA, August 2012.
 Acceptance rate: 19%, 43/222.
Best paper award.
 Named one of *Computing Reviews*' Notable Computing Books and Articles of 2012.
- [26] **Attacking the Washington, D.C. Internet Voting System**
 Scott Wolchok, Eric Wustrow, Dawn Isabel, and J. A. Halderman
 In Angelos D. Keromytis, editor, *Financial Cryptography and Data Security (FC)*, volume 7397 of *Lecture Notes in Computer Science*, pages 114–128. Springer, 2012.
 Acceptance rate: 26%, 23/88.
Election Verification Network John Gideon Memorial Award.
- [27] **Telex: Anticensorship in the Network Infrastructure**
 Eric Wustrow, Scott Wolchok, Ian Goldberg, and J. A. Halderman
Proc. 20th USENIX Security Symposium, pages 459–474, San Francisco, CA, August 2011.
 Acceptance rate: 17%, 35/204.
Runner-up for 2012 PET Award for Outstanding Research in Privacy Enhancing Technologies.
- [28] **Internet Censorship in China: Where Does the Filtering Occur?**
 Xueyang Xu, Z. Morley Mao, and J. A. Halderman
 In Neil Spring and George F. Riley, editors, *Passive and Active Measurement*, volume 6579 of *Lecture Notes in Computer Science*, pages 133–142. Springer, 2011.
 Acceptance rate: 29%, 23/79.

- [29] **Absolute Pwnage: Security Risks of Remote Administration Tools**
 Jay Novak, Jonathan Stribley, Kenneth Meagher, and J. A. Halderman
 In George Danezis, editor, *Financial Cryptography and Data Security (FC)*, volume 7035 of *Lecture Notes in Computer Science*, pages 77–84. Springer, 2011.
 Acceptance rate: 20%, 15/74.
- [30] **Security Analysis of India’s Electronic Voting Machines**
 Scott Wolchok, Eric Wustrow, J. A. Halderman, Hari K. Prasad, Arun Kankipati, Sai Krishna Sakhamuri, Vasavya Yagati, and Rop Gonggrijp
Proc. 17th ACM Conference on Computer and Communications Security (CCS), pages 1–14. ACM, Chicago, IL, October 2010.
 Acceptance rate: 17%, 55/320.
Highest ranked submission.
- [31] **Sketcha: A Captcha Based on Line Drawings of 3D Models**
 Steve Ross, J. A. Halderman, and Adam Finkelstein
Proc. 19th International World Wide Web Conference (WWW), pages 821–830. ACM, Raleigh, NC, April 2010.
 Acceptance rate: 12%, 91/754.
- [32] **Defeating Vanish with Low-Cost Sybil Attacks Against Large DHTs**
 Scott Wolchok, Owen S. Hofmann, Nadia Heninger, Edward W. Felten, J. A. Halderman, Christopher J. Rossbach, Brent Waters, and Emmett Witchel
 In *Proc. 17th Network and Distributed System Security Symposium (NDSS)*. Internet Society, San Diego, CA, February–March 2010.
 Acceptance rate: 15%, 24/156.
- [33] **Fingerprinting Blank Paper Using Commodity Scanners**
 William Clarkson, Tim Weyrich, Adam Finkelstein, Nadia Heninger, J. A. Halderman, and Edward W. Felten
IEEE Symposium on Security and Privacy (Oakland), pages 301–314. IEEE, May 2009.
 Acceptance rate: 10%, 26/254.
- [34] **Lest We Remember: Cold-Boot Attacks on Encryption Keys**
J. A. Halderman, Seth D. Schoen, Nadia Heninger, William Clarkson, William Paul, Joseph A. Calandrino, Ariel J. Feldman, Jacob Appelbaum, and Edward W. Felten
Proc. 17th USENIX Security Symposium, pages 45–60, San Jose, CA, July 2008.
 Acceptance rate: 16%, 27/170.
Best student paper award.
 Pwnie award for most innovative research.
- [35] **Harvesting Verifiable Challenges from Oblivious Online Sources**
J. A. Halderman and Brent Waters
Proc. 14th ACM Conference on Computer and Communications Security (CCS), pages 330–341. ACM, Washington, D.C., October 2007.
 Acceptance rate: 18%, 55/302.

- [36] **Lessons from the Sony CD DRM Episode**
J. A. Halderman and Edward W. Felten
Proc. 15th USENIX Security Symposium, pages 77–92, Vancouver, BC, August 2006.
 Acceptance rate: 12%, 22/179.
- [37] **A Convenient Method for Securely Managing Passwords**
J. A. Halderman, Brent Waters, and Edward W. Felten
Proc. 14th International World Wide Web Conference (WWW), pages 471–479. ACM, Chiba, Japan, May 2005.
 Acceptance rate: 14%, 77/550.
- [38] **New Client Puzzle Outsourcing Techniques for DoS Resistance**
 Brent Waters, Ari Juels, J. A. Halderman, and Edward W. Felten
Proc. 11th ACM Conference on Computer and Communications Security (CCS), pages 246–256. ACM, Washington, D.C., October 2004.
 Acceptance rate: 14%, 35/251.
- [39] **Early Experiences with a 3D Model Search Engine**
 Patrick Min, J. A. Halderman, Michael Kazhdan, and Thomas Funkhouser
Proc. 8th International Conference on 3D Web Technology (Web3D), pages 7–18. ACM, Saint Malo, France, March 2003.
Best paper award.

Book Chapters

- [40] **Practical Attacks on Real-world E-voting**
J. A. Halderman
 In Feng Hao and Peter Y. A. Ryan (Eds.), *Real-World Electronic Voting: Design, Analysis and Deployment*, pages 145–171, CRC Press, 2016.

Journal Publications

- [41] **Lest We Remember: Cold-Boot Attacks on Encryption Keys**
J. A. Halderman, Seth D. Schoen, Nadia Heninger, William Clarkson, William Paul, Joseph A. Calandrino, Ariel J. Feldman, Jacob Appelbaum, and Edward W. Felten
Communications of the ACM, 52(5):91–98, 2009.
- [42] **A Search Engine for 3D Models**
 Thomas Funkhouser, Patrick Min, Michael Kazhdan, Joyce Chen, J. A. Halderman, David P. Dobkin, and David Jacobs
ACM Transactions on Graphics (TOG), 22(1):83–105, 2003.

Refereed Workshop Publications

- [43] **Content-Based Security for the Web**
Alexander Afanasyev, J. A. Halderman, Scott Ruoti, Kent Seamons, Yingdi Yu, Daniel Zappala, and Lixia Zhang
Proc. 2016 New Security Paradigms Workshop (NSPW), September 2016.
- [44] **Umbra: Embedded Web Security through Application-Layer Firewalls**
Travis Finkenauer and J. A. Halderman
Proc. 1st Workshop on the Security of Cyberphysical Systems (WOS-CPS), Vienna, Austria, September 2015.
- [45] **Replication Prohibited: Attacking Restricted Keyways with 3D Printing**
Ben Burgess, Eric Wustrow, and J. A. Halderman
Proc. 9th USENIX Workshop on Offensive Technologies (WOOT), Washington, DC, August 2015.
- [46] **Green Lights Forever: Analyzing the Security of Traffic Infrastructure**
Branden Ghena, William Beyer, Allen Hillaker, Jonathan Pevarnek, and J. A. Halderman
Proc. 8th USENIX Workshop on Offensive Technologies (WOOT), San Diego, CA, August 2014.
- [47] **Zipper ZMap: Internet-Wide Scanning at 10Gbps**
David Adrian, Zakir Durumeric, Gulshan Singh, and J. A. Halderman
Proc. 8th USENIX Workshop on Offensive Technologies (WOOT), San Diego, CA, August 2014.
- [48] **Internet Censorship in Iran: A First Look**
Simurgh Aryan, Homa Aryan, and J. A. Halderman
Proc. 3rd USENIX Workshop on Free and Open Communications on the Internet (FOCI), Washington, D.C., August 2013.
- [49] **Illuminating the Security Issues Surrounding Lights-Out Server Management**
Anthony Bonkoski, Russ Bielawski, and J. A. Halderman
Proc. 7th USENIX Workshop on Offensive Technologies (WOOT), Washington, D.C., August 2013.
- [50] **Crawling BitTorrent DHTs for Fun and Profit**
Scott Wolchok and J. A. Halderman
Proc. 4th USENIX Workshop on Offensive Technologies (WOOT), Washington, D.C., August 2010.
- [51] **Can DREs Provide Long-Lasting Security?**
The Case of Return-Oriented Programming and the AVC Advantage
Steve Checkoway, Ariel J. Feldman, Brian Kantor, J. A. Halderman, Edward W. Felten, and Hovav Shacham
Proc. 2009 USENIX/ACCURATE/IAVoSS Electronic Voting Technology Workshop / Workshop on Trustworthy Elections (EVT/WOTE), Montreal, QC, August 2009.
- [52] **You Go to Elections with the Voting System You Have:**
Stop-Gap Mitigations for Deployed Voting Systems
J. A. Halderman, Eric Rescorla, Hovav Shacham, and David Wagner
In *Proc. 2008 USENIX/ACCURATE Electronic Voting Technology Workshop (EVT)*, San Jose, CA, July 2008.

- [53] **In Defense of Pseudorandom Sample Selection**
Joseph A. Calandrino, J. A. Halderman, and Edward W. Felten
Proc. 2008 USENIX/ACCURATE Electronic Voting Technology Workshop (EVT), San Jose, CA, July 2008.
- [54] **Security Analysis of the Diebold AccuVote-TS Voting Machine**
Ariel J. Feldman, J. A. Halderman, and Edward W. Felten
Proc. 2007 USENIX/ACCURATE Electronic Voting Technology Workshop (EVT), Washington, D.C., August 2007.
- [55] **Machine-Assisted Election Auditing**
Joseph A. Calandrino, J. A. Halderman, and Edward W. Felten
Proc. USENIX/ACCURATE Electronic Voting Technology Workshop (EVT), Washington, D.C., August 2007.
- [56] **Privacy Management for Portable Recording Devices**
J. A. Halderman, Brent Waters, and Edward W. Felten
Proc. 2004 ACM Workshop on Privacy in the Electronic Society (WPES), pages 16–24, ACM, Washington, D.C., October 2004.
Acceptance rate: 22%, 10/45.
- [57] **Evaluating New Copy-Prevention Techniques for Audio CDs**
J. A. Halderman
In Joan Feigenbaum, editor, *Digital Rights Management*, volume 2696 of *Lecture Notes in Computer Science*, pages 101–117. Springer, 2003.

Selected Other Publications

- [58] **The Security Challenges of Online Voting Have Not Gone Away**
Robert Cunningham, Matthew Bernhard, and J. A. Halderman
IEEE Spectrum, November 3, 2016.
- [59] **TIVOS: Trusted Visual I/O Paths for Android**
Earlence Fernandes, Qi Alfred Chen, Georg Essl, J. A. Halderman, Z. Morley Mao, and Atul Prakash
Technical report, Computer Science and Engineering Division, University of Michigan, Ann Arbor, MI, May 2014.
- [60] **Tales from the Crypto Community:
The NSA Hurt Cybersecurity. Now It Should Come Clean**
Nadia Heninger and J. A. Halderman
Foreign Affairs, October 23, 2013.

- [61] **Ethical Issues in E-Voting Security Analysis**
David G. Robinson and J. A. Halderman
In George Danezis, Sven Dietrich, and Kazue Sako, editors, *Financial Cryptography and Data Security*, volume 7126 of *Lecture Notes in Computer Science*, pages 119–130. Springer, 2011.
Invited paper.
- [62] **To Strengthen Security, Change Developers' Incentives**
J. A. Halderman
IEEE Security & Privacy, 8(2):79–82, March/April 2010.
- [63] **Analysis of the Green Dam Censorware System**
Scott Wolchok, Randy Yao, and J. A. Halderman
Technical report, Computer Science and Engineering Division, University of Michigan, Ann Arbor, MI, June 2009.
- [64] **AVC Advantage: Hardware Functional Specifications**
J. A. Halderman and Ariel J. Feldman
Technical report, TR-816-08, Princeton University Computer Science Department, Princeton, New Jersey, March 2008.
- [65] **Source Code Review of the Diebold Voting System**
J. A. Calandrino, A. J. Feldman, J. A. Halderman, D. Wagner, H. Yu, and W. Zeller
Technical report, California Secretary of State's "Top-to-Bottom" Voting Systems Review (TTBR), July 2007.
- [66] **Digital Rights Management, Spyware, and Security**
Edward W. Felten and J. A. Halderman
IEEE Security & Privacy, 4(1):18–23, January/February 2006.
- [67] **Analysis of the MediaMax CD3 Copy-Prevention System**
J. A. Halderman
Technical report, TR-679-03, Princeton University Computer Science Department, Princeton, New Jersey, October 2003.

Selected Legal and Regulatory Filings

- [68] **Request for DMCA Exemption: Games with Insecure DRM and Insecure DRM Generally**
Comment to the Librarian of Congress of J. A. Halderman, represented by B. Reid, P. Ohm, H. Surden, and J. B. Bernthal, regarding the U.S. Copyright Office 2008–2010 DMCA Anticircumvention Rulemaking, Dec. 2008.
(*Outcome*: Requested exemption granted in part.)
- [69] **Request for DMCA Exemption for Audio CDs with Insecure DRM**
Comment to the Librarian of Congress of E. Felten and J. A. Halderman, represented by D. Mulligan and A. Perzanowski, regarding the U.S. Copyright Office 2005–2006 DMCA Anticircumvention Rulemaking, Dec. 2005.
(*Outcome*: Requested exemption granted in part.)

Patents

[70] **Controlling Download and Playback of Media Content**

Wai Fun Lee, Marius P. Schilder, Jason D. Waddle, and J. A. Halderman
U.S. Patent No. 8,074,083, issued Dec. 2011.

[71] **System and Method for Machine-Assisted Election Auditing**

Edward W. Felten, Joseph A. Calandrino, and J. A. Halderman
U.S. Patent No. 8,033,463, issued Oct. 2011.

Speaking

Major Invited Talks and Keynotes

– Let's Encrypt

Invited speaker, TTI/Vanguard conference on Cybersecurity, Washington, D.C., Sept. 28, 2016.

– Elections and Cybersecurity: What Could Go Wrong?

Keynote speaker, 19th Information Security Conference (ISC), Honolulu, September 9, 2016.

– Internet Voting: What Could Go Wrong?

Invited speaker, USENIX Enigma, San Francisco, January 27, 2016.

– Logjam: Diffie-Hellman, Discrete Logs, the NSA, and You

32c3, Hamburg, December 29, 2015.

– The Network Inside Out: New Vantage Points for Internet Security

Invited talk, China Internet Security Conference (ISC), Beijing, September 30, 2015.

– The Network Inside Out: New Vantage Points for Internet Security

Keynote speaker, ESCAR USA (Embedded Security in Cars), Ypsilanti, Michigan, May 27, 2015.

– Security Analysis of the Estonian Internet Voting System.

31c3, Hamburg, December 28, 2014.

– The Network Inside Out: New Vantage Points for Internet Security

Keynote speaker, 14th Brazilian Symposium on Information Security and Computer Systems (SBSEG), Belo Horizonte, Brazil, November 4, 2014.

– Empirical Cryptography: Measuring How Crypto is Used and Misused Online

Keynote speaker, 3rd International Conference on Cryptography and Information Security in Latin America (Latincrypt), Florianópolis, Brazil, September 2014.

– Healing Heartbleed: Vulnerability Mitigation with Internet-wide Scanning

Keynote speaker, 11th Conference on Detection of Intrusions and Malware and Vulnerability Assessment (DIMVA), London, July 10, 2014.

– Fast Internet-wide Scanning and its Security Applications.

30c3, Hamburg, December 28, 2013.

– Challenging Security Assumptions. Three-part tutorial. 2nd TCE Summer School on Computer Security, Technion (Haifa, Israel), July 23, 2013.

- **Verifiably Insecure: Perils and Prospects of Electronic Voting**
Invited talk, Computer Aided Verification (CAV) 2012 (Berkeley, CA), July 13, 2012.
- **Deport on Arrival: Adventures in Technology, Politics, and Power**
Invited talk, 20th USENIX Security Symposium (San Francisco, CA), Aug. 11, 2011.
- **Electronic Voting: Danger and Opportunity**
Keynote speaker, ShmooCon 2008 (Washington, D.C.), Feb. 15, 2008.

Selected Talks (2009–present)

- **The Legacy of Export-grade Cryptography in the 21st Century.** Invited talk, Summer school on real-world crypto and privacy, Croatia, June 9, 2016.
- **Let's Encrypt: A Certificate Authority to Encrypt the Entire Web.** Invited talk, Cubaconf, Havana, April 25, 2016.
- **Logjam: Diffie-Hellman, Discrete Logs, the NSA, and You.** Invited talk, NYU Tandon School of Engineering, April 8, 2016 [host: Damon McCoy]; Invited talk, UIUC Science of Security seminar, February 9, 2016 [host: Michael Bailey].
- **The Network Inside Out: New Vantage Points for Internet Security.** Invited talk, Qatar Computing Research Institute, Doha, May 24, 2015; Invited talk, University of Chile, Santiago, April 8, 2015; Invited talk, Princeton University, October 15, 2014; Invited talk, U.T. Austin, March 9, 2014.
- **Decoy Routing: Internet Freedom in the Network's Core.** Invited speaker, Internet Freedom Technology Showcase: The Future of Human Rights Online, New York, Sep. 26, 2015.
- **The New South Wales iVote System: Security Failures and Verification Flaws in a Live On-line Election.** 5th International Conference on E-Voting and Identity (VoteID), Bern, Switzerland, Sep. 3, 2015; Invited talk, IT Univ. of Copenhagen, Sep. 1, 2015; Invited talk (with Vanessa Teague), USENIX Journal of Election Technologies and Systems Workshop (JETS), Washington, D.C., Aug. 11, 2015.
- **Security Analysis of the Estonian Internet Voting System.** Invited talk, 5th International Conference on E-Voting and Identity (VoteID), Bern, Switzerland, Sep. 3, 2015; Invited talk, Google, Mountain View, CA, June 3, 2014; Invited talk, Copenhagen University, June 12, 2014.
- **Indiscreet Tweets.** Rump session talk; 24th USENIX Security Symposium, Washington, D.C., August 12, 2015.
- **How Diffie-Hellman Fails in Practice.** Invited talk, IT Univ. of Copenhagen, May 22, 2015.
- **Influence on Democracy of Computers, Internet, and Social Media.** Invited speaker, Osher Lifelong Learning Institute at the University of Michigan, March 26, 2015.
- **E-Voting: Danger and Opportunity.** Invited talk, University of Chile, Santiago, April 7, 2015; Keynote speaker, 14th Brazilian Symposium on Information Security and Computer Systems (SBSeg), Belo Horizonte, Brazil, November 3, 2014; Crypto seminar, University of Tartu, Estonia, October 10, 2013; Invited speaker, US–Egypt Cyber Security Workshop, Cairo, May 28, 2013; Invited speaker, First DemTech Workshop on Voting Technology for Egypt, Copenhagen, May

- 1, 2013; Invited keynote, 8th CyberWatch Mid-Atlantic CCDC, Baltimore, MD, Apr. 10, 2013; Invited speaker, Verifiable Voting Schemes Workshop, University of Luxembourg, Mar. 21, 2013; Invited speaker, MHacks hackathon, Ann Arbor, MI, Feb. 2, 2013; Public lecture, U. Michigan, Nov. 6, 2012.
- **Internet Censorship in Iran: A First Look.** 3rd USENIX Workshop on Free and Open Communications on the Internet (FOCI), Aug. 13, 2013.
 - **Mining Your Ps and Qs: Detection of Widespread Weak Keys in Network Devices.** Invited talk, NSA, Aug. 8, 2013; Invited talk, Taiwan Information Security Center Workshop, National Chung-Hsing University (Taichung, Taiwan), Nov. 16, 2012
 - **Securing Digital Democracy.** U. Maryland, Apr. 8, 2013 [host: Jonathan Katz]; CMU, Apr. 1, 2013 [host: Virgil Gligor]; Cornell, Feb. 28, 2013 [host: Andrew Myers].
 - **Telex: Anticensorship in the Network Infrastructure.** Invited speaker, Academia Sinica (Taipei), Nov. 14, 2012 [host: Bo-Yin Yang]; TRUST Seminar, U.C., Berkeley, Dec. 1, 2011 [host: Galina Schwartz]; Think Conference, Nov. 5, 2011; Ideas Lunch, Information Society Project at Yale Law School, Oct. 26, 2011; Invited speaker, Committee to Protect Journalists Online Press Freedom Summit (San Francisco), Sept. 27, 2011.
 - **Deport on Arrival: Adventures in Technology, Politics, and Power.** Guest lecture, U-M School of Art and Design, Nov 5, 2012 [host: Osman Khan]; Invited speaker, CS4HS Workshop, U. Michigan, Aug. 21, 2012; Invited speaker, U. Michigan IEEE, Feb. 15, 2012.
 - **Attacking the Washington, D.C. Internet Voting System.** Invited speaker, International Foundation for Election Systems (IFES), Nov. 2, 2012 [host: Michael Yard]; Invited speaker, IT University of Copenhagen, May 11, 2012 [host: Carsten Schürmann].
 - **Voter IDon't.** Rump session talk; 21st USENIX Security Symposium (Bellevue, WA), Aug. 8, 2012; Rump session talk; EVT/WOTE '12 (Bellevue, WA), Aug. 6, 2012 [with Josh Benaloh].
 - **Reed Smith's Evening with a Hacker.** Keynote speaker (New Brunswick, NJ), Oct. 20, 2011.
 - **Are DREs Toxic Waste?** Rump session talk, 20th USENIX Security Symposium (San Francisco), Aug. 10, 2011; Rump session talk, EVT/WOTE '11 (San Francisco), Aug. 8, 2011.
 - **Security Problems in India's Electronic Voting Machines.** Dagstuhl seminar on Verifiable Elections and the Public (Wadern, Germany), July 12, 2011; Harvard University, Center for Research on Computation and Society (CRCS) seminar, Jan. 24, 2011 [host: Ariel Procaccia]; U. Michigan, CSE seminar, Nov. 18, 2010 [with Hari Prasad]; MIT, CSAIL CIS Seminar, Nov. 12, 2010 [with Hari Prasad; host: Ron Rivest]; Distinguished lecture, U.C. San Diego, Department of Computer Science, Nov. 9, 2010 [with Hari Prasad; host: Hovav Shacham]; U.C. Berkeley, Center for Information Technology Research in the Interest of Society (CITRIS), Nov. 8, 2010 [with Hari Prasad; host: Eric Brewer]; Google, Inc., Tech Talk (Mountain View, CA), Nov. 5, 2010 [with Hari Prasad; host: Marius Schilder]; U.C., Berkeley TRUST Security Seminar, Nov. 4, 2010 [with Hari Prasad; host: Shankar Sastry]; Stanford University, CS Department, Nov. 3, 2010 [with Hari Prasad; host: David Dill]; Princeton University, Center for Information Technology Policy, Oct. 28, 2010 [with Hari Prasad, host: Ed Felten]; University of Texas at Austin, Department of Computer Science, Aug. 27, 2010 [host: Brent Waters].

- **Ethical Issues in E-Voting Security Analysis.** Invited talk, Workshop on Ethics in Computer Security Research (WECSR) (Castries, St. Lucia), Mar. 4, 2011 [with David Robinson].
- **Electronic Voting: Danger and Opportunity.** Invited speaker, “Interfaces 10: Technology, Society and Innovation,” Center for Technology and Society (CTS/FGV) (Rio de Janeiro), Dec. 2, 2010 [host: Ronaldo Lemos]; Invited speaker, Conference on “EVMs: How Trustworthy?,” Centre for National Renaissance (Chennai, India), Feb. 13, 2010; Google, Inc., Tech Talk (Mountain View, CA), Jan. 10, 2008; Star Camp (Cape Town, South Africa), Dec. 8, 2007; Lehigh University, Nov. 27, 2007; Princeton OiT Lunch-’n-Learn, Oct. 24, 2007; University of Waterloo (Canada), Feb. 28, 2007.
- **A New Approach to Censorship Resistance.** Think Conference, Nov. 7, 2010.
- **Practical AVC-Edge CompactFlash Modifications can Amuse Nerds [PACMAN].** Rump session, 19th USENIX Security Symposium (Washington, D.C.), Aug. 11, 2010; Rump session, EVT/WOTE ’10 (Washington, D.C.), Aug. 9, 2010.
- **Legal Challenges to Security Research.** Guest lecture, Law 633: Copyright, U. Michigan Law School, Apr. 7, 2010; Invited talk, University of Florida Law School, Oct. 12, 2006.
- **Adventures in Computer Security.** Invited talk, Greenhills School, grades 6–12 (Ann Arbor, MI), Mar. 8, 2010.
- **The Role of Designers’ Incentives in Computer Security Failures.** STIET Seminar, U. Michigan, Oct. 8, 2009.
- **Cold-Boot Attacks Against Disk Encryption.** Invited speaker, SUMIT 09 Security Symposium, U. Michigan, Oct. 20, 2009.
- **On the Attack.** Distinguished lecture, U.C. Berkeley EECS, Nov. 18, 2009.

Selected Other Speaking (2010–present)

- **Moderator: Apple & the FBI: Encryption, Security, and Civil Liberties.** Panelists: Nate Cardozo and Barbara McQuade. U-M Dissonance Speaker Series, April 12, 2016.
- **Moderator: Privacy, IT Security and Politics.** Panelists: Ari Schwartz and David Sobel. U-M ITS SUMIT_2015, Oct. 22, 2015.
- **Panelist: The Future of E-Voting Research.** 5th International Conference on E-Voting and Identity (VoteID), Bern, Switzerland, Sep. 4, 2015.
- **Moderator: Panel on Research Ethics.** 24th USENIX Security Symposium, Washington, D.C., August 13, 2015.
- **Panelist: Theories of Privacy in Light of “Big Data.”** Michigan Telecommunications and Technology Law Review Symposium on Privacy, Technology, and the Law, University of Michigan Law School, Feb. 21, 2015.
- **Panelist: Measuring Privacy.** Big Privacy symposium, Princeton University CITP, Apr. 26, 2013 [moderator: Ed Felten].

- Panelist: **Civil Society’s Challenge in Preserving Civic Participation**. The Public Voice workshop: Privacy Rights are a Global Challenge, held in conjunction with the 34th International Conference of Data Protection and Privacy Commissioners, Punta del Este, Uruguay, Oct. 22, 2012 [moderator: Lillie Coney].
- Panelist: **Election Technologies: Today and Tomorrow**. Microsoft Faculty Summit (Redmond), July 17, 2012 [moderator: Josh Benaloh].
- Panelist: **Is America Ready to Vote on the Internet?** CSPRI Seminar, George Washington University (Washington, D.C.), May 16, 2012 [moderator: Lance Hoffman].
- Panelist: **Technical Methods of Circumventing Censorship**. Global Censorship Conference, Yale Law School, Mar. 31, 2012.
- Panelist: **Internet Voting**. RSA Conference (San Francisco), Mar. 1, 2012 [moderator: Ron Rivest].
- Panelist: **The Law and Science of Trustworthy Elections**. Association of American Law Schools (AALS) Annual Meeting, Jan. 5, 2012 [moderator: Ron Rivest].
- Panelist: **Connecticut Secretary of State’s Online Voting Symposium** (New Britain, CT), Oct. 27, 2011 [moderator: John Dankosky].
- Panelist: **CS Saves the World**. Michigan CSE Mini-symposium, Mar. 19, 2011 [moderator: Prabal Dutta].
- Panelist: **Cyber Security / Election Technology**. Overseas Voting Foundation Summit, Feb. 10, 2011 [moderator: Candice Hoke].
- ~~Tutorial speaker/organizer: **Security Issues in Electronic Voting**, ICISS (Gandhinagar, India), Dec. 15, 2010 [canceled under threat of deportation].~~
- Invited testimony: **On D.C. Board of Elections and Ethics Readiness for the Nov. 2010 General Election**. D.C. Council Hearing, Oct. 8, 2010.
- Panelist and organizer: **India’s Electronic Voting Machines**. EVT/WOTE (Washington, D.C.), Aug. 9, 2010.
- Panelist: **Ethics in Networking and Security Research**. ISOC Network and Distributed System Security Symposium (San Diego, CA), Mar. 2, 2010 [moderator: Michael Bailey].

Advising and Mentoring

Graduate Students

- Allison McDonald (Ph.D. in progress)
- Matthew Bernhard (Ph.D. in progress)
- Benjamin VanderSloot (Ph.D. in progress)
- David Adrian (Ph.D. in progress)
- Andrew Springall (Ph.D. in progress; NSF Graduate Research Fellowship)
- Zakir Durumeric (Ph.D. in progress; Google Ph.D. Fellowship in Computer Security)
- Travis Finkenauer (M.S. 2016; went on to security position at Juniper Networks)
- Eric Wustrow (Ph.D. 2016; went on to tenure track faculty position at U. Colorado, Boulder)
- James Kasten (Ph.D. 2015; went on to software engineering position at Google)
- Scott Wolchok (M.S. 2011; went on to software engineering position at Facebook)

Post Docs

- Colleen Swanson (2014–15)

Doctoral Committees

- Denis Bueno (C.S. P.D. expected 2016, Michigan)
- Eric Crockett (C.S. Ph.D. expected 2016, Georgia Tech)
- Jakub Czyz (C.S. Ph.D. 2016, Michigan)
- Eric Wustrow (C.S. Ph.D. 2016, Michigan; chair)
- James Kasten (C.S. Ph.D. 2015, Michigan; chair)
- Jing Zhang (C.S. Ph.D. 2015, Michigan)
- Katharine Cheng (C.S. Ph.D. 2012, Michigan)
- Matt Knysz (C.S. Ph.D. 2012, Michigan)
- Zhiyun Qian (C.S. Ph.D. 2012, Michigan)
- Xin Hu (C.S. Ph.D. 2011, Michigan)
- Ellick Chan (C.S. Ph.D. 2011, UIUC)

Undergraduate Independent Work

- 2016: Ben Burgess, Noah Duncan
- 2015: Ben Burgess, Rose Howell, Vikas Kumar, Ariana Mirian, Zhi Qian Seah
- 2014: Christopher Jeakle, Andrew Modell, Kollin Purcell
- 2013: David Adrian, Anthony Bonkoski, Alex Migicovsky, Andrew Modell, Jennifer O’Neil
- 2011: Yilun Cui, Alexander Motalleb
- 2010: Arun Ganesan, Neha Gupta, Kenneth Meagher, Jay Novak, Dhritiman Sagar, Samantha Schumacher, Jonathan Stribley
- 2009: Mark Griffin, Randy Yao

Teaching

- **Introduction to Computer Security**, EECS 388, University of Michigan
Terms: Fall 2017, Fall 2016, Fall 2015, Fall 2014, Fall 2013, Fall 2011, Fall 2010, Fall 2009
Created new undergrad security elective that has grown to reach >750 students/year. An accessible intro, teaches the security mindset and practical skills for building and analyzing security-critical systems.
- **Computer and Network Security**, EECS 588, University of Michigan
Terms: Winter 2016, Winter 2015, Winter 2014, Winter 2013, Winter 2012, Winter 2011, Winter 2010, Winter 2009
Redesigned core grad-level security course. Based around discussing classic and current research papers and performing novel independent work. Provides an intro. to systems research for many students.
- **Securing Digital Democracy**, Coursera (MOOC)
Designed and taught a massive, open online course that explored the security risks—and future potential—of electronic voting and Internet voting technologies; over 20,000 enrolled students.

Professional Service

Program Committees

- 2017 ISOC Network and Distributed Systems Security Symposium (NDSS '17)
- 2016 ACM Internet Measurement Conference (IMC '16)
- 2016 USENIX Security Symposium (Sec '16)
- 2016 International Joint Conference on Electronic Voting (E-VOTE-ID '16)
- 2016 Workshop on Advances in Secure Electronic Voting (Voting '16)
- 2015 ACM Conference on Computer and Communications Security (CCS '15)
- 2015 ACM Internet Measurement Conference (IMC '15)
- 2015 USENIX Security Symposium (Sec '15)
- 2014 ACM Conference on Computer and Communications Security (CCS '14)
- 2014 USENIX Security Symposium (Sec '14)
- 2013 ACM Conference on Computer and Communications Security (CCS '13)
- **Program co-chair**, 2012 Electronic Voting Technology Workshop/Workshop on Trustworthy Elections (EVT/WOTE '12)
- 2012 Workshop on Free and Open Communications on the Internet (FOCI '12)
- 2012 IEEE Symposium on Security and Privacy ("Oakland" '12)
- 2012 International Conference on Financial Cryptography and Data Security (FC '12)
- 2011 Workshop on Free and Open Communications on the Internet (FOCI '11)
- 2011 Electronic Voting Technology Workshop (EVT/WOTE '11)
- 2010 ACM Conference on Computer and Communications Security (CCS '10)
- 2010 USENIX/ACCURATE/IAVOSS Electronic Voting Technology Workshop (EVT '10)
- 2010 USENIX Security Symposium (Sec '10)
- 2010 IEEE Symposium on Security and Privacy (Oakland '10)
- 2010 International World Wide Web Conference (WWW '10)
- 2009 ACM Conference on Computer and Communications Security (CCS '09)
- 2009 ACM Workshop on Digital Rights Management (DRM '09)
- 2009 ACM Workshop on Multimedia Security (MMS '09)
- 2009 USENIX Workshop on Offensive Technologies (WOOT '09)
- 2009 International World Wide Web Conference (WWW '09)
- 2008 ACM Conference on Computer and Communications Security (CCS '08)
- 2008 ACM Workshop on Privacy in the Electronic Society (WPES '08)
- 2008 USENIX/ACCURATE Electronic Voting Technology Workshop (EVT '08)
- 2008 International World Wide Web Conference (WWW '08)

Boards

- Board of Directors for the Internet Security Research Group (2014–present)
- Board of Advisors for the Verified Voting Foundation (2012–present)

- External Advisory Board for the DemTech Project, IT University of Copenhagen (2011–present)
- Advisory Council for the Princeton University Department of Computer Science (2012–2014)

Department and University Service

- Faculty Advisor for Michigan Hackers student group (2012–present)
- CSE Graduate Affairs Committee (member, 2014–present)
- CSE Undergraduate Program Advising (CS/ENG) (2011–present)
- Faculty Senate, Rules Committee of the Senate Assembly (member, 2011–12)
- CSE Graduate Admissions Committee (member, 2010–11)
- CSE Graduate Committee (member, 2009–10)

Broader Impact of Selected Projects

- **Let's Encrypt: A Certificate Authority to Encrypt the Entire Web** (2016)
Co-founded a new HTTPS certificate authority to provide free, browser-trusted, automatically validated certificates for all domains. Developed in partnership with EFF and Mozilla, Let's Encrypt has helped secure millions of websites and is now issuing certificates at a greater rate than all other CAs combined.
- **The Logjam Attack and Weak Practical Use of Diffie-Hellman** (2015)
Introduced Logjam, a practical attack on TLS that affected nearly 10% of popular HTTPS websites. Our results suggest that state-level attackers can break 1024-bit Diffie-Hellman, providing the first parsimonious explanation for how NSA is decrypting widespread VPN traffic, as revealed by Snowden.
- **Security Analysis of the Estonian Internet Voting System** (2014)
Led the first rigorous security review of world's most significant Internet voting system. Based on code review, laboratory testing, and in-person observation, our study revealed significant shortcomings that could allow state-level attackers to upset national elections.
- **ZMap Internet-Wide Scanner Open-Source Project** (2013)
Created ZMap, a network probing tool designed for Internet-wide measurement research that achieves up to 10,000× better performance than earlier tools. Now a thriving open-source project, ZMap is available in major Linux distros. We also maintain [Scans.io](#), a public scan data repository.
- **Detection of Widespread Weak Keys in Network Devices** (2012)
After conducting the largest Internet-wide survey of HTTPS and SSH hosts, we uncovered serious flaws in cryptographic public key generation affecting millions of users. We disclosed vulnerabilities to more than 60 network device makers and spawned major changes to the Linux random number generator.
- **The Telex Anticensorship System** (2011)
Invented a fundamentally new approach to circumventing state-level Internet censorship, based on placing anticensorship technology into core network infrastructure outside the censoring country. Prototype attracted over 100,000 users, mainly in China. Now testing next-gen. schemes at partner ISP.
- **Attacking Washington, D.C.'s Internet Voting System** (2010)
Participated in the first public security trial of an Internet voting system set to be deployed in a real election. We found serious flaws that allowed us to change all votes without detection. This led to the system being scrapped, and the widespread media coverage has altered the debate on Internet voting.

- **Analysis of India’s E-Voting System** (2010)
Participated in the first independent security review of the electronic voting machines used by half a billion voters in India. The flaws uncovered in our work were front-page news. After arresting my coauthor and threatening to deport me, officials eventually moved to adopt a paper trail nationwide.
- **Green Dam Youth Escort Censorware** (2009)
Uncovered security problems and copyright infringement in client-side censorship software mandated by the Chinese government. Findings helped catalyze popular protest against the program, leading China to reverse its policy requiring installation on new PCs.
- **Cold-Boot Attacks** (2008)
Developed the “cold boot” attack against software disk encryption systems, which altered widespread thinking on security assumptions about the behavior of RAM, influenced computer forensics practice, and inspired the creation of a new subfield of theoretical cryptography.
- **California “Top-to-Bottom” Review** (2007)
Helped lead the California Secretary of State’s “top-to-bottom” review of electronic voting machines, the first public review of this technology by any state. Our reports led California to discontinue use of highly vulnerable touch-screen voting systems and altered the course of election technology in the U.S.
- **DMCA Exemptions for Security** (2006 and 2010)
Worked with legal teams to successfully petition the U.S. Copyright Office to create exemptions to the Digital Millennium Copyright Act (which prohibits circumventing DRM) in order to allow the public to investigate and repair security problems caused by certain DRM. One of only six exemptions granted.
- **Sony DRM Rootkit** (2005)
Discovered dangerous security side-effects in the design of copy protection software used for music CDs. Resulted in the recall of millions of discs, class action lawsuits, and an investigation by the U.S. Federal Trade Commission in which I served as a technical expert on DRM’s harm to consumers’ security.
- **The Art of Science** (2004)
Co-founded an interdisciplinary art competition at Princeton University that showcases images and videos produced in the course of scientific research as well as creative works that incorporate tools and ideas from science. Following international attention, the concept has spread to many other campuses.

Outreach and Press Coverage

I'm a regular contributor to [Freedom-to-Tinker](#), a blog hosted by Princeton's CITP. My posts discuss current issues in security and public policy or announce new research results, aiming to communicate findings to nonspecialists.

I'm happy to speak to the press when I believe the topic is important for the public to understand. Much of my research has received significant media attention.

Selected media outlets *Television:* CNN, Fox News, CBS Evening News, NBC Nightly News, MSNBC, CNBC, MTV, Al Jazeera, C-SPAN. *Radio:* NPR News, NPR Science Friday, BBC World Service, The Diane Rehms Show. *Print:* The New York Times, LA Times, USA Today (front page profile), The Wall Street Journal, Washington Post, Boston Globe, Times of India, Time, Fortune, Harpers (incl. Harpers Index), The Atlantic; The Economist, New Scientist, MIT Tech Review, Businessweek, Redbook, PC Magazine, Playboy (long-form profile). *Online:* Hacker News (dozens of top stories), Slashdot (>40 stories), Reddit (top of front page), BoingBoing, CNET News, Wired News, TechNewsDaily, Science Daily, Gizmodo, TechDirt, Ars Technica, The Register, Huffington Post, Politico, The Drudge Report, and hundreds more.

References

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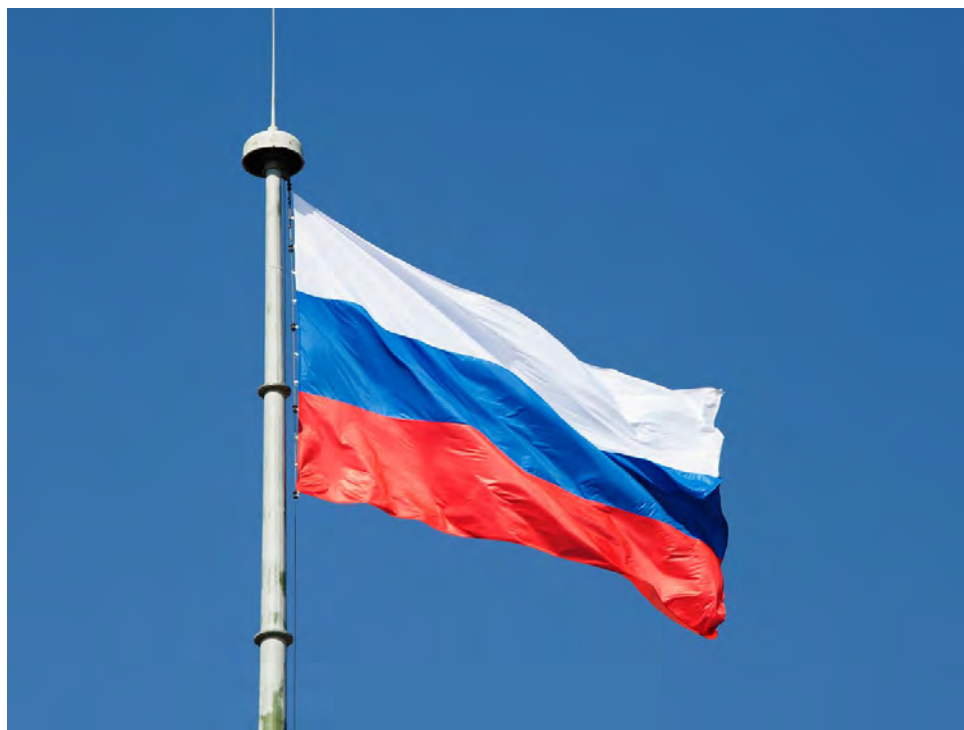
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Exhibit B

APRIL GLASER SECURITY 07.27.16 9:30 AM

HERE'S WHAT WE KNOW ABOUT RUSSIA AND THE DNC HACK



GETTY IMAGES

AS THE DEMOCRATIC National Convention continues its week-long stay in Philadelphia, accusations of Russian hacking continue to cloud the proceedings. At this point, it seems likely that Russia is responsible. What's less clear is what that will mean going forward.

It's been a bad stretch for the Democratic National Committee. Hackers broke into its servers months ago, stealing private emails, opposition research, and campaign correspondence. Last Friday, Wikileaks made nearly 20,000 of those private emails public, revealing embarrassing details of the political machine's inner workings. DNC officials allege that the Russian government is behind the breach. The *New York Times* reports that US intelligence agencies increasingly share that opinion. According to a number of top cybersecurity researchers, they're probably right.

A Brief History of a Hack

News of the hack of the Democratic National Committee first broke in mid-June. That's when CrowdStrike, a firm that analyzes threats to network security, revealed that the DNC had called it in to inspect the party's servers, where it found "two separate Russian intelligence-affiliated adversaries present in the DNC network." CrowdStrike released a comprehensive report of its findings on June 14, which accompanied a *Washington Post* article detailing the attacks. One of the hacking groups, CrowdStrike found, had access to the DNC servers for almost a year.

A day after that report, someone calling themselves Guccifer 2.0 (an allusion to notorious hacker Guccifer) claimed responsibility for the hack in a blog post. Through the blog and an accompanying Twitter account, Guccifer 2.0 refuted CrowdStrike's claims that this was a Russian operation, instead calling himself a "lone hacker." He also claimed to have handed much of the DNC bounty to Wikileaks.

The following week, two cybersecurity firms, Fidelis Cybersecurity and Mandiant, independently corroborated CrowdStrike's assessment that Russian hackers infiltrated DNC networks, having found that the two groups that hacked into the DNC used malware and methods identical to those used in other attacks attributed to the same Russian hacking groups.

But some of the most compelling evidence linking the DNC breach to Russia was found at the beginning of July by Thomas Rid, a professor at King's College in London, who discovered an identical command-and-control address hardcoded into the DNC malware that was also found on malware used to hack the German Parliament in 2015. According to German security officials, the malware originated from Russian military intelligence. An identical SSL certificate was also found in both breaches.

The evidence mounts from there. Traces of metadata in the document dump reveal various indications that they were translated into Cyrillic. Furthermore, while Guccifer 2.0 claimed to be from Romania, he was unable to chat with Motherboard journalists in coherent Romanian. Besides which, this sort of hacking wouldn't exactly be outside of Russian norms.

"It doesn't strain credulity to look to the Russians," says Morgan Marquis-Boire, a malware expert with CitizenLab. "This is not the first time that Russian hackers has been behind intrusions in US government, and it seems unlikely that it will be the last." Last year Russian hackers were able to breach White House and State

Department email servers, gleaning information even from President Obama's BlackBerry.

Meanwhile, the Kremlin has denied Russian involvement in the DNC breach. But the reverberations continue; DNC Chairwoman Debbie Wasserman Schultz will resign at the end of the week, after emails revealed what many view as the unfair treatment of Bernie Sanders.

From Russia With Love

As compelling as the evidence is, there's still a small amount of room to argue that Guccifer 2.0 was a lone actor, an individual motivated by hacktivist ideals of dismantling state power. He wouldn't be the first. And in a recent interview on NBC, Julian Assange of Wikileaks gave a soft disavowal of claims that his whistleblowing organization is in cahoots with Russian intelligence, "Well, there is no proof of that whatsoever," he said. "We have not disclosed our source, and of course, this is a diversion that's being pushed by the Hillary Clinton campaign."

This is, of course, the same Assange who boasts responsibility for helping find Snowden a home in Russia and Wikileaks publicly criticized the Panama Papers for implicating Putin in financial misdeeds. He's also an outspoken frequent critic of Hillary Clinton's time at the State Department. A damning document dump the weekend before Clinton's nomination arguably aligns with both Russian interests and his own.

If the allegations do prove correct, this is an unprecedented step for Russia. Hacking is nothing new, but publicizing documents to attempt to sway an election certainly is. Putin would clearly prefer a Trump presidency. The billionaire Republican candidate is a longtime admirer of Putin's, and has publicly stated that he wouldn't necessarily defend NATO allies against a Russian invasion. To top it all off, Trump's campaign manager, Paul Manafort, formerly worked as an advisor to Viktor Yanukovich, the Russian-backed President of Ukraine before he was ousted in 2014.

"Due to the nature and timing of this hack, it all seems very political," says Marquis-Boire.

And there's a whole lot of election left—and likely more leaks to come with it. On Sunday, a Twitter user asked Wikileaks if more DNC leaks were on their way. The reply: "We have more coming."

Update: In a press conference Wednesday, Republican presidential candidate Donald Trump invited Russia to retrieve “missing” emails from Hillary Clinton’s campaign and release them. Cybersecurity experts described the remarks as “unprecedented” and “possibly illegal.”

Exhibit C

The New York Times | <http://nyti.ms/2eqNSVY>

 ELECTION 2016 | Full Results | Exit Polls | Trump's Cabinet

Private Security Group Says Russia Was Behind John Podesta's Email Hack

By NICOLE PERLROTH and MICHAEL D. SHEAR OCT. 20, 2016

SAN FRANCISCO — At the start of 2014, President Obama assigned his trusted counselor, John D. Podesta, to lead a review of the digital revolution, its potential and its perils. When Mr. Podesta presented his findings five months later, he called the internet's onslaught of big data “a historic driver of progress.” But two short years later, as chairman of Hillary Clinton's presidential campaign, Mr. Podesta would also become one of the internet's most notable victims.

On Thursday, private security researchers said they had concluded that Mr. Podesta was hacked by Russia's foreign intelligence service, the GRU, after it tricked him into clicking on a fake Google login page last March, inadvertently handing over his digital credentials.

For months, the hackers mined Mr. Podesta's inbox for his most sensitive and potentially embarrassing correspondence, much of which has been posted on the WikiLeaks website. Additions to the collection on Thursday included three short

email exchanges between Mr. Podesta and Mr. Obama himself in the days leading up to his election in 2008.

Mr. Podesta's emails were first published by WikiLeaks earlier this month. The release came just days after James R. Clapper Jr., the director of national intelligence, and the Department of Homeland Security publicly blamed Russian officials for cyberattacks on the Democratic National Committee, in what they described as an effort to influence the American presidential election.

To date, no government officials have offered evidence that the same Russian hackers behind the D.N.C. cyberattacks were also behind the hack of Mr. Podesta's emails, but an investigation by the private security researchers determined that they were the same.

Threat researchers at Dell SecureWorks, an Atlanta-based security firm, had been tracking the Russian intelligence group for more than a year. In June, they reported that they had uncovered a critical tool in the Russian spy campaign. SecureWorks researchers found that the Russian hackers were using a popular link shortening service, called Bitly, to shorten malicious links they used to send targets fake Google login pages to bait them into submitting their email credentials.

The hackers made a critical error by leaving some of their Bitly accounts public, making it possible for SecureWorks to trace 9,000 of their links to nearly 4,000 Gmail accounts targeted between October 2015 and May 2016 with fake Google login pages and security alerts designed to trick users into turning over their passwords.

Among the list of targets were more than 100 email addresses associated with Hillary Clinton's presidential campaign, including Mr. Podesta's. By June, 20 staff members for the campaign had clicked on the short links sent by Russian spies. In June, SecureWorks disclosed that among those whose email accounts had been targeted were staff members who advised Mrs. Clinton on policy and managed her travel, communications and campaign finances.

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Two security researchers who have been tracking the GRU's spearphishing campaign confirmed Thursday that Mr. Podesta was among those who had inadvertently turned over his Google email password. The fact that Mr. Podesta was among those breached by the GRU was first disclosed Thursday by Esquire and the Motherboard blog, which published the link Russian spies used against Mr. Podesta.

"The new public data confirming the Russians are behind the hack of John Podesta's email is a big deal," Jake Sullivan, Mrs. Clinton's senior policy adviser, said Thursday. "There is no longer any doubt that Putin is trying to help Donald Trump by weaponizing WikiLeaks."

The new release of Mr. Podesta's email exchange with Mr. Obama from 2008 made clear that Mr. Obama's team was confident he would win.

In one of the emails, Mr. Podesta wrote Mr. Obama a lengthy memo in the evening on Election Day recommending that he not accept an invitation from President George W. Bush to attend an emergency meeting of the Group of 20 leaders.

"Attendance alongside President Bush will create an extremely awkward situation," the memo said. "If you attempt to dissociate yourself from his positions, you will be subject to criticism for projecting a divided United States to the rest of the world. But if you adopt a more reserved posture, you will be associated not only with his policies, but also with his very tenuous global standing."

The White House did not respond to questions about the email.

Correction: October 22, 2016

An article on Friday about suspected email hacking by Russia's foreign intelligence service misstated the name of one organization that first disclosed that a presidential counselor, John D. Podesta, was among those whose accounts were breached. The blog is Motherboard, not VICE Motherload.

Nicole Perlroth reported from San Francisco, and Michael D. Shear from Washington.

Follow The New York Times's politics and Washington coverage on Facebook and Twitter, and sign up for the First Draft politics newsletter.

A version of this article appears in print on October 21, 2016, on page A14 of the New York edition with the headline: Private Security Group Says Russia Was Behind Hack of Clinton Campaign Chairman.

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Exhibit D

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NEWS > U.S. NEWS

WORLD INVESTIGATIONS CRIME & COURTS ASIAN AMERICA LATINO NBCBLK

NEWS AUG 30 2016, 4:54 AM ET

Russians Hacked Two U.S. Voter Databases, Officials Say

by ROBERT WINDREM, WILLIAM M. ARKIN and KEN DILANIAN

SHARE



Hackers based in Russia were behind two recent attempts to breach state voter registration databases, fueling concerns the Russian government may be trying to interfere in the U.S. presidential election, U.S. intelligence officials tell NBC News.

The breaches included the theft of data from as many as 200,000 voter records in Illinois, officials say.

The incidents led the FBI to send a "flash alert" earlier this month to election officials nationwide, asking them to be on the lookout for any similar cyber intrusions.

One official tells NBC News that the attacks have been attributed to Russian intelligence agencies.

"This is the closest we've come to tying a recent hack to the Russian government," the official said.

That person added that "there is serious concern" that the Kremlin may be seeking to sow uncertainty in the U.S. presidential election process.



Voters cast their ballots at ChiArts High School on March 15 in Chicago, Illinois. © Scott Olson / Getty Images

Two other officials said that U.S. intelligence agencies have not yet concluded that the Russian government is trying to do that, but they are worried about it.

Russians Hacked Two U.S. Voter Databases, Officials Say, NBC News

They said the Russians have long conducted cyber espionage on political targets. The question now is whether they are moving into a covert intelligence operation designed to destabilize the U.S. political process.

The alert, first reported by Yahoo News, provided IP addresses associated with the hack attempts, though it did not mention Russia.

One of the IP addresses was involved in both breaches, the FBI alert said.

"The FBI is requesting that states contact their Board of Elections and determine if any similar activity to their logs, both inbound and outbound, has been detected," the alert said.

The bulletin does not identify the targeted states, but officials told NBC News they were Illinois and Arizona. Illinois officials said in July that they shut down their state's voter registration after a hack. State officials said Monday the hackers downloaded information on as many 200,000 people.

State officials told the Chicago Tribune they were confident no voter record had been deleted or altered.

In Arizona, officials said, hackers tried to get in using malicious software but were unsuccessful. The state took its online voter registration down for nine days, beginning in late June, after malware was discovered on a county election official's computer. But the state concluded that the system was not successfully breached.

Those incidents led Homeland Security Secretary Jeh Johnson to host a call earlier this month with state election officials to talk about cybersecurity and election infrastructure.

Johnson said DHS isn't aware of any specific cyber threat against election-related networks, but he urged officials to examine how to better secure their systems, according to a summary of the call put out by the department.

U.S. intelligence officials have previously said Russian intelligence agencies were behind hacks into the Democratic National Committee and related organizations. There has been a long running debate among intelligence analysts about what Russia is up to.

Voting systems have not been considered "critical infrastructure," by the Department of Homeland Security, so they are not subject to federal government protections.

Independent assessments have found that many state and local voting system are extremely vulnerable to hacking. 🌈



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FIRST PUBLISHED AUG 29 2016, 6:05 PM ET

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Exhibit E



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Joint Statement from the Department Of Homeland Security and Office of the Director of National Intelligence on Election Security

Release Date: October 7, 2016



For Immediate Release
DHS Press Office
Contact: 202-282-8010

The U.S. Intelligence Community (USIC) is confident that the Russian Government directed the recent compromises of e-mails from US persons and institutions, including from US political organizations. The recent disclosures of alleged hacked e-mails on sites like DCLeaks.com and WikiLeaks and by the Guccifer 2.0 online persona are consistent with the methods and motivations of Russian-directed efforts.

These thefts and disclosures are intended to interfere with the US election process. Such activity is not new to Moscow—the Russians have used similar tactics and techniques across Europe and Eurasia, for example, to influence public opinion there. We believe, based on the scope and sensitivity of these efforts, that only Russia's senior-most officials could have authorized these activities.

Some states have also recently seen scanning and probing of their election-related systems, which in most cases originated from servers operated by a Russian company. However, we are not now in a position to attribute this activity to the Russian Government. The USIC and the Department of Homeland Security (DHS) assess that it would be extremely difficult for someone, including a nation-state actor, to alter actual ballot counts or election results by cyber attack or intrusion. This assessment is based on the decentralized nature of our election system in this country and the number of protections state and local election officials have in place. States ensure that voting machines are not connected to the Internet, and there are numerous checks and balances as well as extensive oversight at multiple levels built into our election process.

Nevertheless, DHS continues to urge state and local election officials to be vigilant and seek cybersecurity assistance from DHS. A number of states have already done so. DHS is providing several services to state and local election officials to assist in their cybersecurity. These services include cyber “hygiene” scans of Internet-facing systems, risk and vulnerability assessments, information sharing about cyber incidents, and best practices for securing voter registration databases and addressing potential cyber threats. DHS has convened an Election Infrastructure Cybersecurity Working Group with experts across all levels of government to raise awareness of cybersecurity risks potentially affecting election infrastructure and the elections process. Secretary Johnson and DHS officials are working directly with the National Association of Secretaries of State to offer assistance, share

information, and provide additional resources to state and local officials.

#

Last Published Date: October 7, 2016

Exhibit F

U.S. official: Hackers targeted voter registration systems of 20 states



In this June 5, 2015, file photo, the Homeland Security Department headquarters in northwest Washington. A Homeland Security Department official says hackers have targeted the voter registration systems of more than 20 states in recent months. FBI Director James Comey told lawmakers this week that the agency is looking "very, very hard" at **Russian** hackers who may try to disrupt the U.S. election. (Susan Walsh / AP)

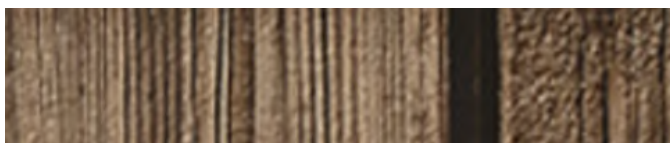
By **Tribune news services**

SEPTEMBER 30, 2016, 4:42 PM | WASHINGTON

Hackers have targeted the voter registration systems of more than 20 states in recent months, a Homeland Security Department official said Friday.

The disclosure comes amid heightened concerns that foreign hackers might undermine voter confidence in the integrity of U.S. elections. Federal officials and many cybersecurity experts have said it would be nearly impossible for hackers to alter an election's outcome because election systems are very decentralized and generally not connected to the internet.

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The official who described detecting the hacker activity was not authorized to speak publicly on the subject and spoke to The Associated Press on condition of anonymity. It was unclear, the official said, whether the hackers were foreign or domestic, or what their motives might be. ABC News earlier reported that more than 20 states were targeted.

The FBI last month warned state officials of the need to improve their election security after hackers targeted systems in Illinois and Arizona. FBI Director [James Comey](#) told lawmakers this week that the agency is looking "very, very hard" at Russian hackers who may try to disrupt the U.S. election.

Last month, Donald Trump, the GOP nominee for president, suggested that he feared the general election "is going to be rigged."

The Homeland Security Department has stepped up its outreach to states and localities, but it is up to them to ask for help. So far, 19 states have expressed interest in a general "cyber hygiene" scan of key websites — akin to ensuring that windows in a home are properly closed, according to another Homeland Security official directly involved in securing local elections who also was not authorized to speak publicly about ongoing efforts.

The FBI has detected a variety of "scanning activities" that are early indications of hacking, Comey told the House Judiciary Committee this week.

The FBI held a conference call on Friday with the local officials who run elections in the battleground state of Florida. Meredith Beatrice, a spokeswoman for Secretary of State Ken Detzner, called it an "informational call related to elections security," but a person on the call who was not authorized to discuss it and requested anonymity said authorities had seen evidence of someone probing a local elections website.

Homeland Security Secretary [Jeh Johnson](#) spoke to state election officials by phone last month, encouraging them to implement existing technical recommendations to secure their election systems and ensure that electronic voting machines are not connected to the internet.

DHS is offering states more comprehensive, on-site risk and vulnerability checks. Only four states have expressed interest in the assessment, and because the election is only weeks away, the department will likely only be able to conduct an assessment of one state before Election Day on Nov. 8, the official said.

Two of the hacking attempts involved efforts to mine data from the Arizona and Illinois voter registration systems, according to Kay Stimson, a spokeswoman for the National Association of Secretaries of State. She said in Arizona a hacker tried to probe voter registration data, but never infiltrated the system, while in Illinois hackers got into the system, but didn't manipulate any data.

These systems have "nothing to do with vote casting or counting," Stimson said in an email. "While it is theoretically possible to disrupt an election by infiltrating a voter registration system, their compromise would not affect election results" and there are system controls in place to catch any fraud.

Rep. [Henry Johnson](#), D-Ga., introduced two bills earlier this month that would require voting systems be designated as critical infrastructure and limit purchases of new voting systems that don't provide paper ballots, among other measures. It's unlikely the bills will be passed before the election.

The Homeland Security Department is already considering designating voting systems as critical infrastructure in the future, though it is unlikely to happen before the election, the second official said.

A presidential directive released in 2013 details 16 sectors that are considered critical infrastructure, including energy, financial services, healthcare, transportation, food and agriculture, and communications. The designation places responsibilities on the Homeland Security secretary to identify and prioritize those sectors, considering physical and cyber threats. The secretary is also required to conduct security checks and provide information about emerging and imminent threats.

Associated Press

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This article is related to: [Jeh Johnson](#), [James Comey](#)

Exhibit G

11/24/2016 Case 2:16-cv-06287-PD Document 9-1 Filed 12/06/16 Page 73 of 83

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Ukraine election narrowly avoided 'wanton destruction' from hackers (+video)

A brazen three-pronged cyber-attack against last month's Ukrainian presidential elections has set the world on notice – and bears Russian fingerprints, some say.

By Mark Clayton, Staff writer | JUNE 17, 2014

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David Mdzinarishvili/Reuters | View Caption

A three-pronged wave of cyber-attacks aimed at wrecking Ukraine's presidential vote – including an attempt to fake computer vote totals – was narrowly defeated by government cyber experts, Ukrainian officials say.

The still little-known hacks, which surfaced May 22-26, appear to be among the most dangerous cyber-attacks yet deployed to sabotage a national election – and a warning shot for future elections in the US and abroad, political scientists and cyber experts say.

National elections in the Netherlands, Norway, and other nations have seen hackers probe Internet-tied election systems, but never with such destructive abandon, said experts monitoring the Ukraine vote.

Recommended: How much do you know about cybersecurity? Take our quiz.

"This is the first time we've seen a cyber-hacktivist organization act in a malicious way on such a grand scale to try to wreck a national election."

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Jack Detsch

Staff writer | Jack is the Mark Clayton Fellow in Cybersecurity

malicious way on such a grand scale to try to wreck a national election, says Joseph Kiniry, an Internet voting systems cyber-security expert. “To hack in and delete everything on those servers is just pillaging, wanton destruction.”

That wanton destruction began four days ahead of the national vote, when CyberBerkut, a group of pro-Russia hackers, infiltrated Ukraine’s central election computers and deleted key files, rendering the vote-tallying system inoperable. The next day, the hackers declared they had “destroyed the computer network infrastructure” for the election, spilling e-mails and other documents onto the web as proof.

A day later, government officials said the system had been repaired, restored from backups, and was ready to go. But it was just the beginning.

Only 40 minutes before election results were to go live on television at 8 p.m., Sunday, May 25, a team of government cyber experts removed a “virus” covertly installed on Central Election Commission computers, Ukrainian security officials said later.

If it had not been discovered and removed, the malicious software would have portrayed ultra-nationalist Right Sector party leader Dmytro Yarosh as the winner with 37 percent of the vote (instead of the 1 percent he

actually received) and Petro Poroshenko (the actually winner with a majority of the vote) with just 29 percent, Ukraine officials told reporters the next morning.

Curiously, Russian Channel One aired a bulletin that evening declaring Mr. Yarosh the victor with 37 percent of the vote over Mr. Poroshenko with 29 percent, Ukraine officials said.

“Offenders were trying by means of previously installed software to fake election results in the given region and in such a way to discredit general results of elections of the President of Ukraine,” the Ukrainian Security Service (SBU) said in a statement.

Still, there was more to come.

In the wee hours of the morning after polls closed, as results flowed in from Ukrainian election districts, Internet links feeding that data to the vote tally system were hit with a barrage of fake data packets – known as distributed denial of service (DDoS) attacks. So from about 1 to 3 a.m. on May 26, election results were blocked, delaying the finally tally until the early



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Jason Healey
Columnist | Senior Research Scholar, Columbia University SIPA



Sascha Meinrath
Columnist | Sascha founded the Open Technology Institute.



Lysa Myers
Columnist | Lysa Myers is a security researcher at ESET.



Bruce Schneier
Columnist | Bruce is a noted cryptographer and security expert.



Evan Selinger
Columnist | Evan is a philosophy professor at Rochester Institute of Technology.



Melanie Teplinsky
Columnist | Melanie teaches information privacy law at American University.



Nicole Wong
Columnist | Nicole served as deputy chief technology officer at the White House.



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morning, a preliminary report by international election observers recounted.

An analysis of the DDoS attack by Arbor Networks, a Burlington, Mass., cyber-security company, ties it to CyberBerkut.

In the end, international observers declared Ukraine's vote "a genuine election." But US researchers say it's clear that Ukraine dodged a major cyber-bullet.

"We've seen vote fraud before in Ukraine, including a rigged computer system in 2004," says Peter Ordeshook, a California Institute of Technology political scientist. "But this wasn't an effort to steal the election outcome, so much as to steal the election itself – by entirely discrediting it in the eyes of key segments of the population in Ukraine and in Russia, too."

While it was well understood across most of Ukraine and internationally that the far-right candidate Yarosh had little political support, the faked results would have lent credibility to Russian-inspired accounts that the popular revolt last fall against the Ukraine government was fomented by ultra-nationalists.

"In that light, the cyber fakery looks incredibly clumsy from the outside because no one there would have believed it," Dr. Ordeshook says. "But these faked results were geared for a specific audience in order to feed the Russian narrative that has claimed from the start that ultra-nationalists and Nazis were behind the revolution in Ukraine."

If the virus with the faked computer results had not been discovered, it would have fomented unrest across the volatile ethnic-Russian Donetsk region now under the shadow of Russian forces on the border with Ukraine, he says. Such spurious results also would have undermined the credibility of the new Ukraine government and could have paved the way for Russian military action, say political scientists who monitor Ukraine elections.

The Ukraine hack is a stark warning for the US and other democracies that use the Internet for tabulation and even direct voting, election security experts say. One clear lesson, they say, is to always have paper ballots to back up election results – like Ukraine – and to avoid Internet voting.

"The Ukraine attack story demonstrates there is no shortage of methods which a determined adversary will make use of to sabotage an election," says Pamela Smith, president of the Verified Voting Foundation, a US group that has researched US election systems security.

In the runup to the election, President Obama on May 2 warned Russia not to interfere or the US "will not have a choice but to move forward with additional, more severe sanctions."

Since then, US officials appear reluctant to make too much of the attacks. References to the cyber-attacks have been brief and oblique. With anonymity cloaking cyber-attacks across the Internet, it's difficult to tell



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anonymity cloaking cyber attacks across the internet, it's difficult to tell how deeply involved Russia's government might have been.

Ukraine experienced "cyber-attacks on the Central Election Commission of the kind that generally would require outside support," Victoria Nuland, assistant secretary of State for European affairs, acknowledged in a May 27 interview on the Charlie Rose show. Mark Green, a former congressman, said in Senate testimony June 6 that he had been told by a US diplomat of a failed Russian cyber-attack on the election.

Ukrainian officials have been unabashed in throwing blame at Russia, saying that arrests were made in the case, although no names have yet been made public.

"It was prepared in advance and stored on Russian (Internet) re-sources," Volodymyr Zverev, head of the Ukraine's Administration of Public Service of Special Communication and Protection of Information said of the malware that was intended to deliver the fake election results, according to Interfax-Ukraine. "They wanted to, and made the preparations, but they did not succeed."

While Russian hacktivists appear to be linked to at least some of the attacks, not everyone agrees the Russian government had a hand in the most devious element. Internet security expert Mr. Kiniry, for instance, says there is no solid proof yet to back the Ukrainian government claim of a virus carrying fake election results.

Others say Russia's paw prints are all over the attack.

"Did Russia attempt to sway the Ukrainian Presidential Election? I honestly don't know the answer to that," says Jeffery Stutzman, CEO of Red Sky Alliance, a cyber-security group in New Hampshire.

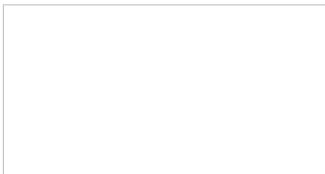
But, he adds, "the idea that these guys were trying to poison the election result by compromising the election commission computers is amazing to me – and this coincidence with the Russian channel showing the same fake results – is just too much. If it walks like a duck and quacks like one, maybe it's a duck." ■

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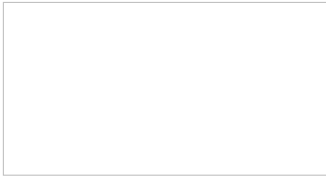
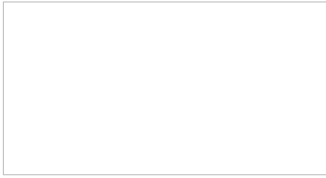
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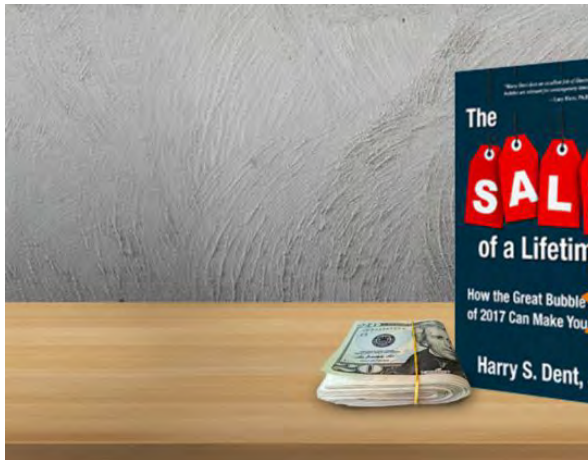


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Exhibit B

COMMONWEALTH OF PENNSYLVANIA
COUNTY OF _____

PETITION TO RECOUNT AND/OR RECANVASS
AND AFFIDAVIT OF [your name] _____

**TO THE _____ COUNTY BOARD OF ELECTIONS, [name of
county]_____, PENNSYLVANIA:**

_____, verifies, deposes and says the following under penalty of
perjury:

1. My name is _____. I am a registered voter in City, Borough,
Township of _____, Precinct [insert number] _____,
_____ County, Pennsylvania. I voted in this district in the election on
November 8, 2016. I live at [insert complete street address]
_____, _____ County, Pennsylvania.

2. Pursuant to 25 P.S. § 3154, I request a recount and recanvass of the vote for
President of the United States and for United States Senate in the November 8, 2016 election in
this district.

3. I believe that an error, although not apparent on the face of the returns, has been
committed in the vote in this district. I also believe there is a discrepancy in the returns of this
district.

4. My belief is based, in part, on the attached Affidavit of Alex Halderman, which
raises grave concerns about the integrity of optical scan voting machines used in this district.
See Ex. A (attached).

5. Because this election district “uses an electronic voting system utilizing paper ballots,” the “county board shall recount all ballots using manual, mechanical or electronic devices of a different type used for the specific election.” 25 P.S. § 3154(e)(3)(i).

6. I request that the county board manually count all of the paper ballots for President of the United States and United States Senate in the district, and compare those tallies to the optical scan results. As the Halderman Affidavit makes clear, the only way to ensure the integrity and accuracy of the vote is to count all of the paper ballots manually.

7. As a voter, and as a citizen of this country, I believe it is extremely important that votes are counted accurately in this election.

8. I hereby verify under penalty of perjury that the facts contained in this petition and affidavit are true and correct to the best of my knowledge or information and belief.

[Signature]

Sworn to before me this _____ day of November 2016.

Notary Public

VERIFICATION

I hereby depose and say that the statements in the foregoing Petition to Recount and/or Recanvass are true and correct to the best of my knowledge, information and belief. I understand that this statement is made subject to the penalties of 18 Pa. C. S. Sec 4904 relating to unsworn falsification to authorities.

[signature]

Exhibit C



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Election law as passed by the legislature and interpreted by the Courts has become increasingly complex. The Bureau of Elections encourages you to consult with your political party or an attorney regarding your election questions.

Thank you.

Delaware County Bureau of Elections